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Why Solar designs industrial gas turbines to weigh between 1 and 1½ lb/hp

by Paul A. Pitt

Chief Engineer
Solar Aircraft Company

The weight of Solar gas turbines is the result of a design philosophy that is unique in the small gas turbine field.

Most gas turbine designs fall into one of two extreme categories. Aircraft-type engines, at one extreme, embody highly sophisticated techniques for extreme light weight in relation to horsepower, but have resulting short life. The opposite philosophy employs the ultra-massiveness of steam turbines to assure long life.

There are important disadvantages in both approaches when long life, reasonable cost, dependable operation, simple maintenance and easy transportation and installation are required. While aircraft-design engines (of ¼ to ½ hp/lb) can be modified and derated for longer service life, the resulting product is inherently delicate. This compromise inevitably results in short life.

Paul A. Pitt

On the other hand, massive design (of 10 lb/hp and up) leads to unnecessary structural bulk and introduces problems of thermal lag and distortion.

Since World War II, Solar has designed and built a variety of gas turbine units with characteristics that lead to both long life and low weight. The Saturn gas turbine engine, for example, is an 1100 hp unit intended specifically for industrial and military installations. It has a weight-to-power ratio of 1.1 to 1.4 lb/hp.

Although it is designed for long life, it utilizes only enough materials in its components to satisfy structural and thermal requirements. This approach resulted in a design that makes no compromises with durability and performance, yet meets the needs of industry for flexibility in a small package. It has an 1100 hp rating at a specific fuel consumption of 0.61 lb/hp-hr and a continuous rating of 1020 hp at 0.63 lb/hp-hr SFC.

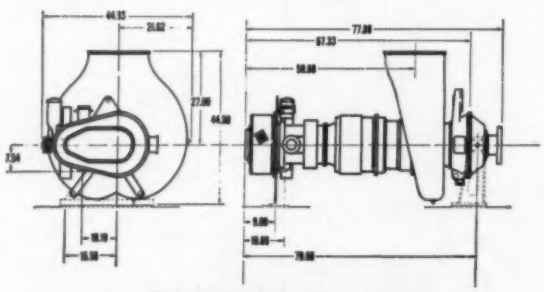
Meeting these objectives required an engine with a simple thermodynamic cycle and high efficiency components. An axial compressor was designed with an operating efficiency of 86%, and this was combined with a multi-stage, axial type turbine of advanced aerodynamic design. Over-all dimensions of the engine are shown in the figure below.

To fulfill workhorse service requirements, the engine was designed to operate at a conservative gas temperature of 1450 F continuous rating. The stress levels are also low, so that major rotating and stationary components will have more than 100,000 hours of life with long periods between overhaul. To keep costs down and assure dependability, the engine design is simple and straightforward.

In brief, the development program of the Saturn turbine adhered to three principles: Careful aerodynamic design for high performance; use of moderate temperatures and low stress levels for long life; and exhaustive component testing for ruggedness and reliability.

Presently scheduled field applications of the Saturn turbine include: Power source for 750 kw electric generator sets in process plants, portable field equipment, pipeline pumping, and gas compression in the petro-chemical industry. Other uses are as a power source for a 600 kw generator set in a commercial marine installation, propulsion units for marine and amphibious vehicles, and prime movers for off-highway vehicles.

Detailed data on Solar gas turbines and other turbomachinery is available. Write Dept. H-122, Solar Aircraft Company, San Diego 12, California.



Saturn T-1000 dimensions

SOLAR
AIRCRAFT COMPANY

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Above: After welding together two sections of volute (one shown below) the areas adjacent to the welds are high frequency induction heated to 1950°F. prior to quenching.

Below: Section of volute which is fabricated entirely of Stainless Steel Type 316, for handling of liquid metal at 1250°F.

Stainless Steel Volute for liquid metal...

fabricated by Pittsburgh Piping

This stainless steel volute was fabricated by Pittsburgh Piping for a leading builder of nuclear energy equipment. The job was awarded to us because we have highly specialized facilities, plus broad experience in nucleonic piping work. This experience began when we fabricated piping for the Nautilus and for the main coolant lines of the Shippingport atomic-powered central station. It has been extended and expanded through the work we have been doing for the atomic-powered submarine and surface vessels now being built, and for scores of government and industrial nuclear energy installations. Use this experience on your next nucleonic piping job. Our representative will call on request, or we will be glad to have you visit our plant.

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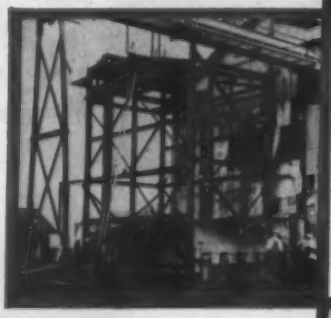
U. S. PLYWOOD solved its need for greater steam capacity *with a*



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KEELER MK

water tube steam generator

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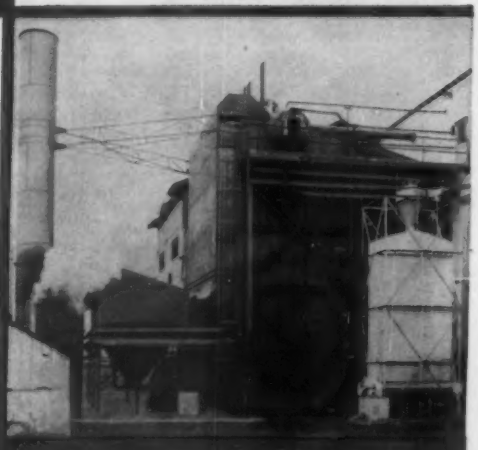


THE PROBLEM...

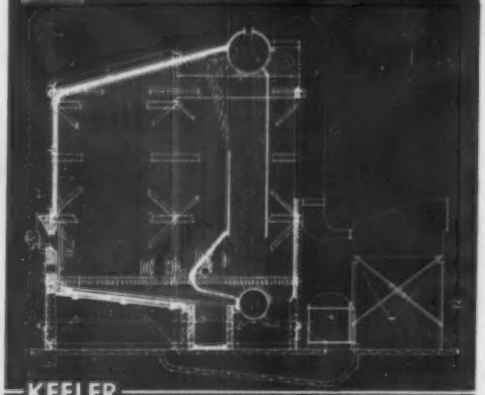
Sawmill, dry kiln and plywood manufacturing operations required greater, more flexible steam capacity to supply varying loads *(40,000 to 105,000 lbs/hr at 250 psi)*. Existing facility inadequate. Single unit must be suitable for firing plant's "hogged fuel" by-product.

THE SOLUTION...

An outdoor installation of a Keeler Type MK Water Tube Steam Generator—124,000 lbs/hr capacity, 275 lbs design pressure for solid fuel firing. The Keeler MK was erected in close quarters adjacent to old boiler house without interrupting plant's work schedule.

OPERATIONAL REPORT...

Keeler MK supplying entire steam requirement with capacity to spare. Functioning properly, operating economically, giving trouble-free performance. *Over-all requirements fully met with complete satisfaction.*



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All purpose cross drum water tube type steam generators provide high efficiency with any method of firing—for coal, oil, gas or waste fuel operation (or combinations), with ready convertibility.

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PUBLISHED SIN E 1896 FOR POWER ENGINEERS IN PRIVA AND PUBLIC UTILITIES AND INDUSTRIAL ARTS

ENGINEERS' PREVIEW

CONSTRUCTION of a 360,000-kw atomic electric power plant is expected to be started next year by Southern California Edison Co. The closed-cycle water reactor would be designed and built by Westinghouse, who also would supply the steam and electrical equipment. Over-all plant cost is estimated at approximately $70,000,000. Bechtel Corp would be the engineering constructors.

Based on Westinghouse and Edison studies, the plant would be economically competitive with conventional plants over its lifetime. According to present estimates, such a plant would require about four years to construct.

Briefly described, this type of plant has a 300-ton reactor vessel in which uranium oxide fuel elements are suspended. Water under a pressure of 2000 psi is circulated around these fuel elements, circulates through a heat exchanger, and transfers heat to a secondary system where water is converted to steam to turn the turbine generator.

PROPOSED American Standard on compressor systems is in preparation. The present tentative draft is known as Safety Standards for Compressor Systems, ASA B19.1. Copies for criticism and comment may be obtained free of charge by writing to George C. Finster, Standards Manager, ASME, 29 W. 39th St, New York 18, N. Y. All requests should be on letterhead.

SMITH MOUNTAIN combination hydroelectric project on the Roanoke River in Virginia will be the largest combined river flow and pumped storage installation in the United States. It will be owned and operated by Appalachian Power Co, a major operating company of the American Electric Power System. The AEP Service Corp has awarded contracts totaling $11½ million for major equipment for the project, including turbines, generators, transformers and switchgear to be furnished by Baldwin-Lima-Hamilton Corp, Allis-Chalmers, General Electric, Elliott Co. Div of Carrier Corp, and Westinghouse.

A concrete arch dam will be built at Smith Mountain Gap, the upper site. Lower dam will be located about 18 river miles below the upper dam and about three miles upstream from Leesville.

Firm peak generating capacity of all generators will be 440,000 kw, and provision is being made at the upper dam for the addition of another 140,000-kw unit some time in the future to bring the project capacity to 580,000 kw.

The two dams will combine conventional generation of hydroelectric power with pumped storage.

1959 LAMME MEDAL of AIEE has been awarded to Lee A. Kilgore, manager of engineering at Westinghouse's East Pittsburgh Division. Kilgore is the 32nd recipient of the Medal, which was founded on a bequest by Benjamin G. Lamme, chief engineer of the Westinghouse Electric and Manufacturing Co (now Westinghouse Electric Corp), and to be awarded to a member of AIEE "who has shown meritorious achievement in the development of electric apparatus or machinery."

Elmer L. Lindseth, president of Cleveland Electric Illuminating Co since 1945, has been elected chairman of the Board. Ralph M. Besse, executive vice-president, was elected president.

James F. Fairman, senior vice-president, Consolidated Edison Co of New York, will this month receive the 1960 National Society of Professional Engineers' Award for outstanding service to the engineering profession.

Edmond B. Hymmen has been named chief engineer of Stone & Webster Canada Ltd, affiliate of Stone & Webster Engineering Corp of Boston.

● 1960 PACIFIC General Meeting of AIEE will be held at El Cortes Hotel in San Diego, Calif, Aug 8–12.

Edison Electric Institute's 28th annual convention is being held in Atlantic City, June 6–8.

63rd annual meeting of the American Society for Testing Materials will be held in Atlantic City, Chalfonte-Haddon Hall, June 26–July 1.

24th National Exposition of Power and Mechanical Engineering will be held at the New York Coliseum, Nov 28 to Dec 2. The biennial display will be held, as usual, under the auspices of ASME in conjunction with its annual meeting.

● **PRACTICAL PROBLEMS and experience in the utilization of solar energy, wind power and geothermic energy, particularly with reference to less developed countries, will be the subject of a United Nations conference on new sources of energy which is scheduled to be held in Europe from August 17 to 27, 1961.**

The conference will focus attention on applications rather than on the discussion of scientific principles and basic research. Solar energy will be given the major place on the agenda.

Another future meeting of interest to power engineers, to be held in Copenhagen, Denmark, in June of 1962, is the International Congress on Combustion Engines (CIMAC). Theme will center on recent developments with diesel engines and gas turbines above 3000 hp and with gas engines above 1500 hp. Conference contact in the U. S.: Robert L. Stanley, 2000 K St, N. W., Washington 6, D. C.

● STRATHMORE PAPER CO is installing a new $1,300,000 power plant to provide electricity and steam for its two paper mills in Woronoco, Mass. Turbine is rated at 3100 kw, providing more than enough power for the two mills and also for the community of Woronoco. This is an extraction steam turbine. Steam enters the turbine at high pressure to spin the blades and is then extracted at the pressure required to meet process needs — 175 lb at the Woronoco mills.

Steam to spin the turbine will be produced by a Riley Stoker Corp boiler, of water tube, water wall construction, operating at 625 psi and 725 F. Boiler can burn either pulverized coal or Bunker C fuel oil separately or simultaneously.

Although extensive structural work has been necessary, the company is utilizing the existing power plant building for the new installation. The boiler is inside the building, and much of the auxiliary equipment is on the roof.

Coal silo storage of 400 tons is one of the requirements of the station, for when coal is being used the boiler will burn around 65 tons a day.

Problem of fly ash is being solved with a Prat-Daniel dust collector. All ash and soot is taken out automatically and is discharged into a special ash silo. The ash dumping system has special equipment that sprays water onto the fly ash as it goes into a dump truck to be hauled away.

● **ELECTRICITY from the atom is now flowing into northern Illinois homes, farms, offices and factories for the first time from Commonwealth Edison Co's Dresden Nuclear Power Station. First output from the plant reached 64,000 kw, will be stepped up gradually.**

Activation of the Dresden plant marks the initial electric production from the largest nuclear power reactor in service or under construction in this country. At its full capacity of 180,000 kw, Dresden will produce enough electricity to supply the needs of a city of 200,000 people.

● DAYSTROM, INC is supplying two general-purpose computer operational information systems to two southern electrical power utilities.

First system will be installed as part of the new 182,000-kw coal-fired electric generating station which Carolina Power and Light Co is erecting at Darlington, N. C. Second computer is being delivered to the new 150,000-kw Willow Glen station of the Gulf States Utilities Co at St. Gabriel, La.

Both systems are designed to provide operators of a station with all the data required for its most efficient operation, and to do essential computations required for decision-making. To do that job, they will monitor from 300 to 400 critical points throughout the stations, and scan these points for temperatures, pressures, and flows at the rate of five points per second.

● **ITALIAN Research Reactor, located at Ispra, near Milan, is the major nuclear research center of the Italian Government and one of the key nuclear research centers in Europe. Because of the completeness of its nuclear research facilities and its central location, the Italian Government has agreed to place the entire installation under the direction of the Euratom organization, the joint atomic energy authority for France, Belgium, Italy, Holland, West Germany and Luxembourg.**

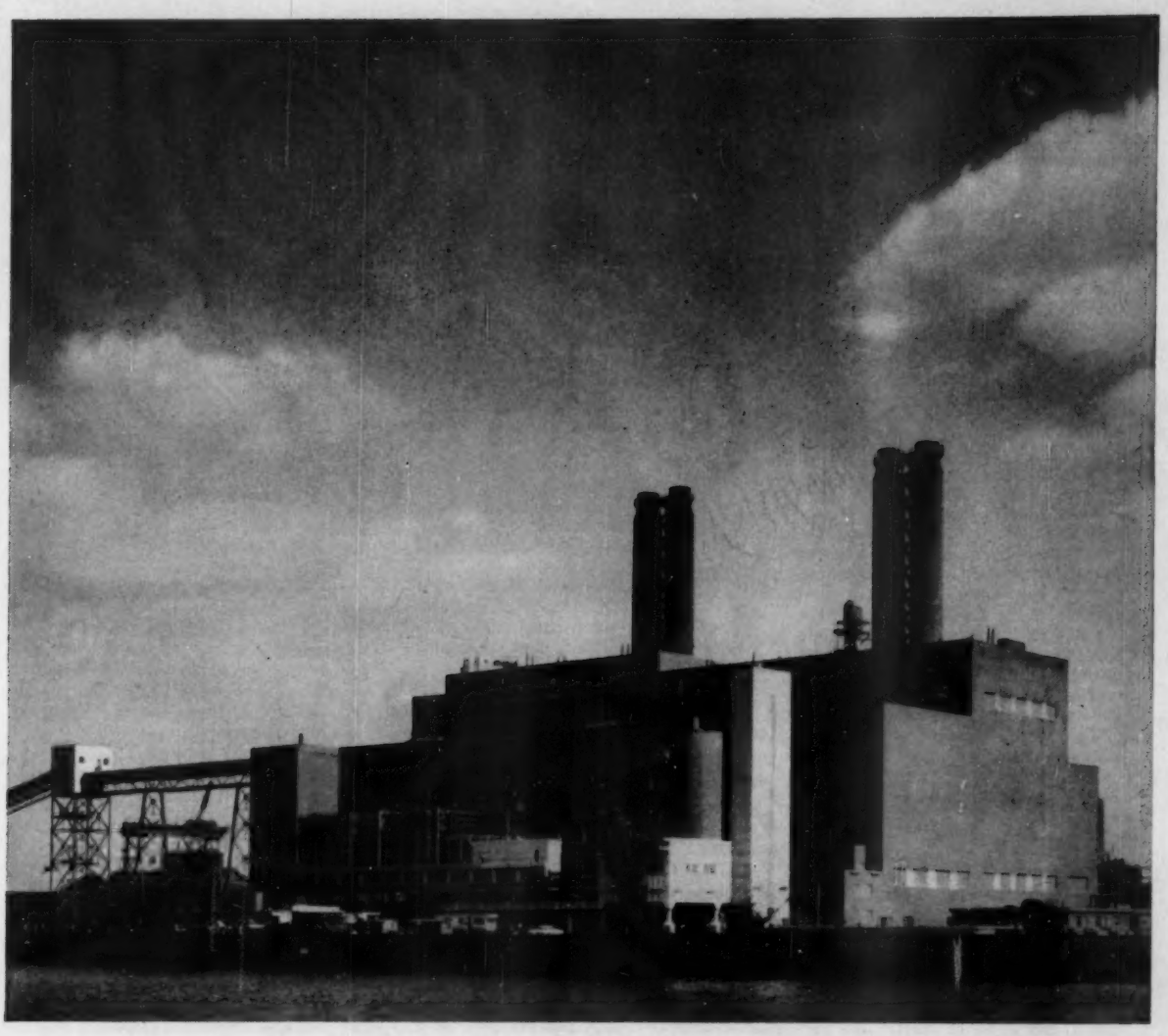
Included in the transfer will be the reactor and a new operating fuel which is being supplied by Sylvania-Corning Nuclear Corp. The reactor was fueled at its first loading in early 1959 with 20 per cent enriched uranium elements. These will be replaced with 90 per cent enriched uranium fuel elements to provide higher reactivity.

● LISTING of abstracted Russian technical journals currently available by subscription from the Office of Technical Services has now been published. It shows some 100 Soviet technical periodicals abstracted regularly by U. S. Government agencies and released to the public through OTS as part of its program of collection and dissemination of translated technical literature. The listing, *English Abstracts of Russian Technical Journals*, may be ordered without charge from OTS, U. S. Department of Commerce, Washington 25, D. C.

● **ELECTRIC INDUSTRY has 42,000,000 kw of new capacity scheduled for operation, more than 90 per cent of which will be installed by the end of 1963. So reports the Edison Electric Institute in its 27th semi-annual survey. The total represents an increase of 9.6 per cent over the schedule of 38,300,000 kw reported at the beginning of the year.**

Electric energy output in 1960 is expected to reach 770 billion kwh; it was 707 billion kwh in 1959. Annual nation-wide output by 1963 is estimated at about one trillion kwh.

Peak load for the contiguous U. S. (excluding Alaska and Hawaii) in December of this year is predicted as 133,600,000 kw, or 9.8 per cent greater than the peak load for December of last year.



Main condenser in Consolidated Edison Astoria No. 4 Unit will use Ambraloy-927 aluminum brass tubes

To meet New York's growing power needs, Consolidated Edison Co. adds a 340,000-kw block of generating capacity this year, when it starts up its Astoria No. 4 Unit. The American Brass Company is supplying half of the tubes for the main condenser—12,250 tubes, each 7/8" O.D. x .049" wall, of Ambraloy-927. This aluminum brass condenser tube alloy was developed by Anaconda to provide high corrosion resistance to clean and polluted sea water. It has established an excellent service record in steam power plants and oil refineries along the seacoasts—and in marine service on high-speed turbine-driven vessels. The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

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Made by The American Brass Company

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WHAT THEY TELL US

▶ **IN THE MARCH ISSUE,** we published a brief account, page 82, of the sea water converter which is being used experimentally in the operation of Southern California Edison's Mandalay Beach plant. This has been reported as the first sea water conversion plant of its kind to be used in conjunction with an existing steam electric generating station. Reader C. K. Lewis of San Francisco comments:

> Your March issue carries a misstatement. Page 82 states that the Southern California Edison plant at Mandalay Beach is the first general-purpose sea water conversion plant on the Pacific Coast. Not so! PG & E's Morro Bay plant was placed in operation several years ago, and in its initial construction incorporated conversion features, and it has since used sea water for its entire operation.
>
> The Morro Bay plant uses fewer stages of evaporation than Mandalay, but the net result is the same — conversion of sea water for supply to a steam power plant.

▶ **IN HIS ARTICLE** in the January issue, James E. Tebay of Beckman Scientific and Process Instruments spoke of accuracy in coal weighing. He commented that "measurements today are accurate only to plus or minus 4 per cent at best." To this statement H. Bandstra, advertising manager of Richardson Scale Co, takes vigorous exception, and writes:

> This is somewhat astounding because automatic coal scales by Richardson Scale Co and by a couple of other firms have consistently advertised a guaranteed accuracy of within ¼ of 1 per cent, and actual practice has demonstrated the accuracy to be well within 1/10th of 1 per cent.
>
> If the article had been referring only to measurements rather than actual weighing, there might have been room for such a range, although even measurements are generally considered to be accurate within 2 per cent nowadays. Nobody would accept inaccuracies running to 4 per cent as suggested in this article.

To these observations, Mr. Tebay replies:

> It is one thing to take a static measurement of a carload of coal and quite another to measure coal under varying demands of a dynamic steam station which needs to know both the small amount of fuel during start-up as well as the tremendous amount of coal when generating 1000 F steam at the rate of 1,000,000 lb/hr or more.
>
> The statements in my article did not come from casual observation of the industry, but rather from lengthy discussions with users, engineering contractors, other instrument companies, and last but not least, editors of trade journals. It seems we all still agree that the measurement performed over the dynamic range necessary is subject to absolute accuracy errors due to the difficulty of calibration as well as reproducibility errors caused by hysteresis.
>
> Of course we are always interested in new techniques, and it is quite possible that Mr. Bandstra's company has introduced new equipment capable of such measurements.

▶ **EASY-TO-UNDERSTAND** summaries of patents applying to the electronics, petroleum processing, petrochemical, chemical, and pharmaceutical fields are being offered by a new firm, Industrial Patent Research Co of Columbus, Ohio. The service reduces patents to digests of the basic principles involved, free from legal terminology. Philip E. Corbett, director of this new service, tells us:

> After analyzing and processing several thousand patents, we have observed that an abstract of good quality is one which includes only the schematically accurate coverage of the novel function or feature. This extract-abstract deletes the redundant phrases and old English wordage which obscures the direct technical message that engineers must interpret quickly. Accordingly, we have applied this system of analysis.

▶ **ARTHUR S. FLEMMING,** Secretary of Health, Education, and Welfare, has been citing some striking figures on the nation's water problem. He reports that

> . . . during the period 1950 to 1957, while our population increased 12½ per cent, the total fresh water used increased 57 per cent. Where we now use 270 billion gallons of water per day, by 1980 we will need 600 billion gallons per day — more than double our present requirements . . . We don't stand a chance of meeting these accelerating requirements unless we make marked progress in the direction of cleaning up our streams and keeping them clean . . . For 40 years we have been dumping more pollution into the surface waters of the nation than we have been removing through waste treatment.

Senator Robert S. Kerr of Oklahoma, chairman of the Senate's Select Committee on National Water Resources, says that the most serious aspect of the national water problem is the lack of public awareness of its existence. As Sen. Kerr interprets it:

> While most Americans tend to take water for granted, authorities say the amount which can be made available for use is definitely limited. Demands are expected to double by 1980, soaring to about 600 billion gallons daily. This is close to the ceiling on the total supply engineers think can be made available, as a practical matter, under present engineering knowledge and techniques.
>
> However, future prospects need not be gloomy. Water authorities say that with good management we can get along within this apparent ceiling on supply . . . but it will take ample reservoirs to store streamflows, maximum reuse of water, elimination of pollution, rigid reduction in waste of water, successful scientific research on how to make better use of present sources, and possibly development of new sources.

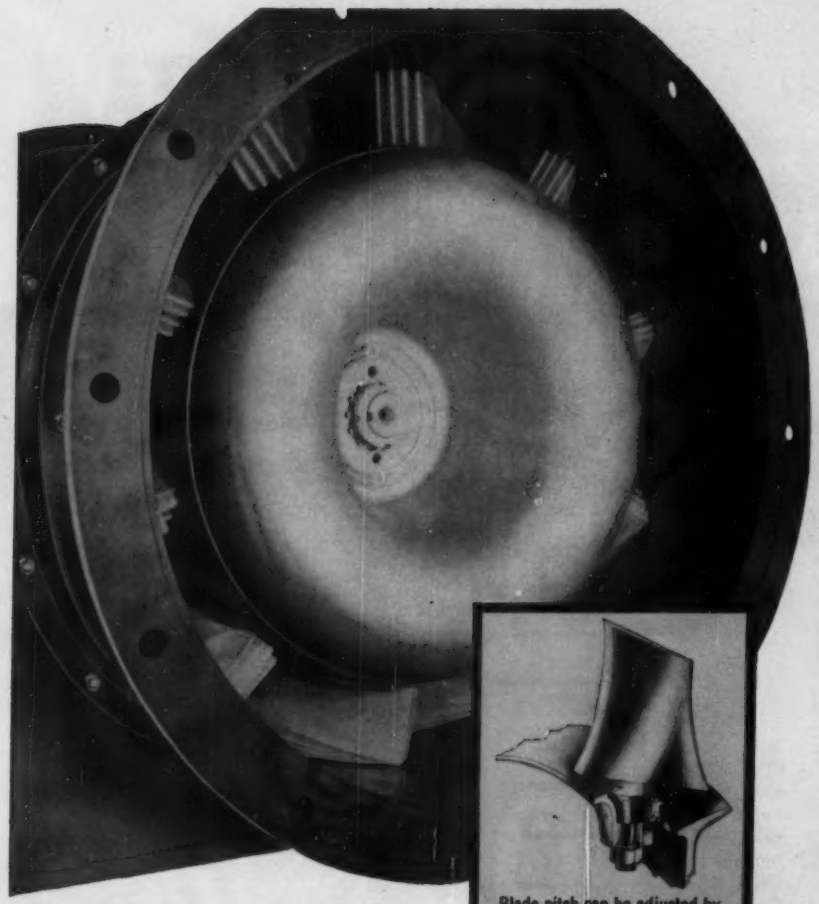
▶ **INSTRUMENTATION** and automation have moved up into the forefront of management's attention, says George M. Muschamp, a Minneapolis-Honeywell vice-president.

> Where before the sole initiative seemed to be in the hands of instrument specialists, working against an almost apathetic management, today management is taking a more attentive, if not aggressive position with respect to automatic control . . . Continuing rise in labor costs, the sharp competition in price and quality both at home and abroad, the expansion into new fields with limited technical and production manpower are factors which really leave top management with little choice but to push automation to the utmost.

▶ **SEVERAL** of our readers have challenged Mr. Goggin's article, What Oil Burning System for the Automatic Package Boiler?, which appeared in POWER ENGINEERING in April.

Exception has been taken to parts of the article which refer to rotary-cup burners, and to the "turn-down ratio" of mechanical pressure atomizing burners.

Since we always wish to present both sides of a question, we are asking a number of experts to offer comments, and we will soon publish an article summarizing our findings.



Multiple exposure shows fan blades through the full range of pitch changes.

Blade pitch can be adjusted by loosening one nut, resetting the blade to desired position on calibrated scale, and retightening the nut.

Joy Design Means:

MINIMUM POWER CONSUMPTION WITH VARIABLE FAN OUTPUT

Blade pitch on Joy Axivane® Fans can be adjusted easily. This means that the volumetric output of Joy fans can be varied by as much as ± 20% without any sacrifice of fan efficiency, and therefore with minimum power consumption. And with no efficiency losses such as are encountered with dampers and variable inlet vanes. (Where efficiency losses may be tolerated, the volumetric output may be changed by as much as 400%.)

Even at full load, Joy Axivane Fans are more efficient than propeller, tube-axial and centrifugal fans. The direct drive achieved by mounting the motors inside the fan housings eliminates drive losses, and the vane-axial design gives maximum aerodynamic efficiency. Mounting the motors in the housings also makes the Joy Axivane Fans more compact, and less costly to install.

Fans available range from types which weigh as little as a pound and have a diameter of a few inches, up to some which weigh tons and have diameters up to twelve feet. If you need spot cooling, area ventilation, or any movement of air, Joy can supply the most efficient answer.

For complete information, write for Bulletin 1278-56C.

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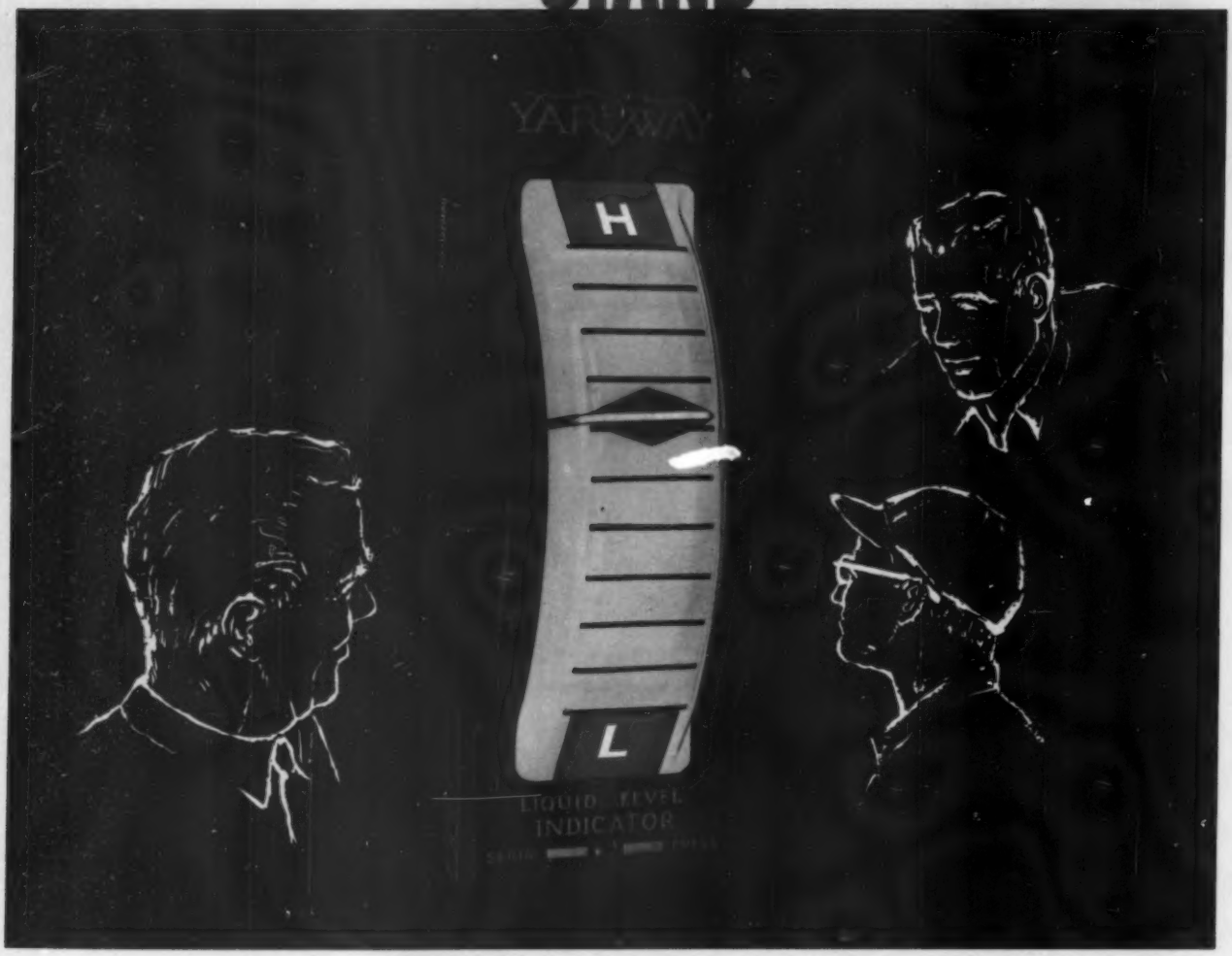

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REPUBLIC STEEL CORP.
FORD MOTOR COMPANY
UNION BAG & PAPER COMPANY
WESTINGHOUSE ELECTRIC CORP.
GENERAL ELECTRIC COMPANY
STAUFFER CHEMICAL COMPANY
WILSON & COMPANY
U. S. STEEL COMPANY
GENERAL MOTORS
MOBIL OIL COMPANY

UTILITIES

(Code Case #1155 Installations)

COMMONWEALTH EDISON
IOWA ILLINOIS GAS & ELECTRIC
CENTRAL ILLINOIS PUBLIC SERVICE
ILLINOIS POWER CO.
WISCONSIN POWER & LIGHT
LAKE SUPERIOR DISTRICT POWER
NORTHERN STATES POWER CO.
PUBLIC SERVICE OF INDIANA
INDIANAPOLIS POWER & LIGHT
IOWA ELECTRIC LIGHT & POWER
NEBRASKA POWER
NEW ENGLAND POWER
ROCHESTER GAS & ELECTRIC CO.
PENNSYLVANIA ELECTRIC CO. (ERIE, PA.)
OMAHA PUBLIC SERVICE
CENTRAL ILLINOIS ELECTRIC
NARRAGANSETT ELECTRIC CO.
LOUISIANA POWER & LIGHT
HARTFORD ELECTRIC LIGHT CO.
POTOMAC ELECTRIC POWER CO.

WATER LEVEL INDICATION ?

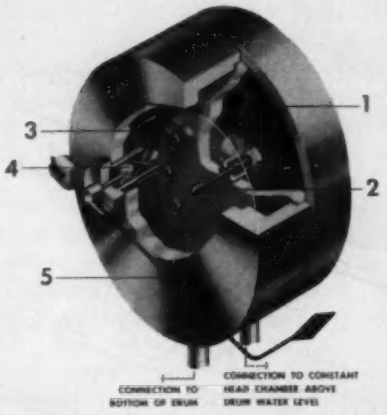
YARWAY REMOTE INDICATORS HAVE BRILLIANT "WIDE ANGLE" VISIBILITY... CAN BE INSTANTLY READ FROM MULTIPLE VANTAGE POINTS

Yarway Remote Liquid Level Indicators bring distant, often hard-to-see boiler level readings right down to eye level on the panel board or other convenient location.

No matter where you stand—at any point in a 180° arc, and from a considerable distance—the brilliant new wide vision dial makes viewing and reading easy.

GIVE INSTANT, ACCURATE READINGS BECAUSE INDICATOR IS OPERATED BY THE BOILER WATER ITSELF

Remote readings of levels in boilers (also feed water heaters and other heat exchangers) are instant and accurate because indicator *operating mechanism* is actuated by the varying head of the liquid itself, yet the *pointer mechanism* is never under pressure.



Constant pressure from a controlled-temperature constant head chamber located above drum level is maintained on one side of diaphragm (1) in indicator. Varying pressure changing with water level is maintained on opposite side of diaphragm. Change in differential between the two pressures moves the diaphragm which in turn regulates, through deflection plate (2), magnet (3), and spiral magnetic armature (4), the position of the counterbalanced pointer (5).

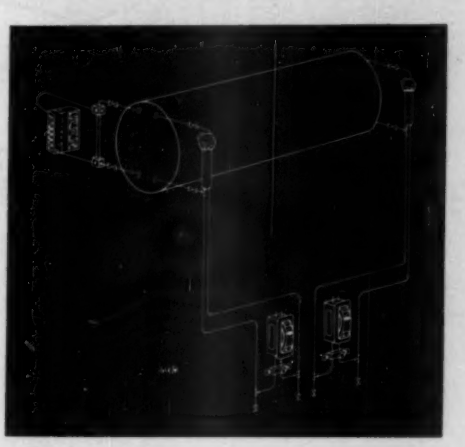
OPERATE ADDITIONAL REMOTE SIGNAL ALARMS, HORNS OR LIGHTS

With the addition of a control unit Yarway Indicators may be equipped to operate auxiliary hi-lo signal alarms, horns or lights located at any place in the plant. Electronic secondary indicators may also be used to duplicate readings at remote points.

FULLY APPROVED AS PRIMARY INDICATING ELEMENTS UNDER BOILER CODE CASE #1155

Under A.S.M.E. Boiler Code Committee ruling in Case #1155, two independent remote level indicators of compensated manometric type may be used instead of one of two required gage glasses for boiler pressures 900 psi and above. When both indicators are in operation, the gage glass may be shut off but shall be maintained in serviceable condition.

Yarway Remote Liquid Level Indicators conform to this ruling and are used widely for primary boiler water level indication in plants operating at 900 psi and above.



All Yarway Indicators for service over 700 psi are temperature-compensated; pressure compensation available when desired. Use of controlled-temperature column on constant head chamber fully protects against system upsets.

If you would like a reprint of this Boiler Code ruling, just ask for Case #1155 reprint.

Get the full story on Yarway Liquid Level Indication for your plant. Write for new 24-page Bulletin WG-1825.

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY
A MARK OF QUALITY IN STEAM ENGINEERING

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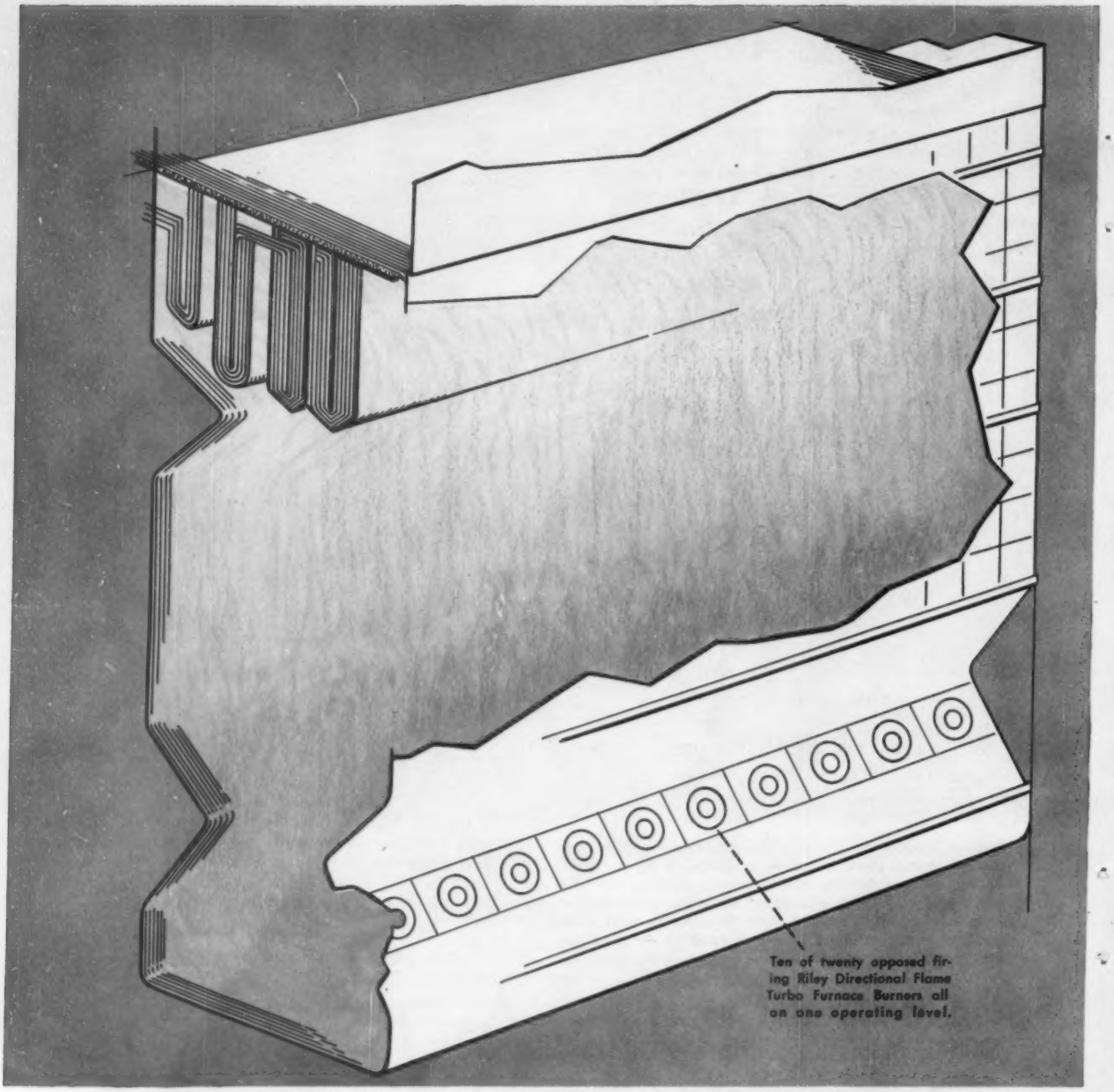
BY *"Doing What Comes Naturally"*

The RILEY Produces Uniform



Sales Offices: Boston, Charlotte, Chicago, Cincinnati, Cleveland, Detroit, Houston, Jacksonville, Kansas City, Los Angeles, New Orleans, New York, Philadelphia, Pittsburgh, Portland, St. Louis, St. Paul, Salt Lake City, San Francisco, Seattle, Syracuse.

TURBO FURNACE

Exit Temperature With *NATURAL* Flow of Furnace Gases

Uniform, safe gas temperatures across the full width of a boiler's high pressure elements is a vital requirement for continuous, efficient, low cost, trouble-free boiler operation, especially in high pressure, high temperature units. With a Riley TURBO FURNACE this objective is obtained . . . and . . . WITHOUT using costly auxiliary methods for distributing furnace gases.

In the TURBO FURNACE all fossil fuels — gas, oil, coal — are burned at the base of the furnace with combustion extending evenly from sidewall to sidewall. The cutaway illustration shows combustion gases rising within the furnace envelope in a uniform wall to wall column resulting in a minimum variation of metal skin temperatures across the full width of both the superheater and the reheater. The maximum variations above normal operating temperatures are well within safe alloy limits assuring long tube life.

Because of natural, uniform furnace gas flow and distribution steam temperature control is also simplified, furnace slagging is minimized — deslagging equipment is rarely required. Flyash and air pollution problems are minimized. Higher heat releases and wider single undivided furnaces are possible.

The advanced design of the TURBO FURNACE represents an important step forward toward more efficient boiler operation. Because any available fuel can be burned at any time without major alterations the TURBO FURNACE boiler is the ideal "Convertible" furnace for today's and tomorrow's fuel economics.

A new graphically illustrated TURBO FURNACE catalog is available. Ask your Riley Representative.

Some Typical Riley Turbo Furnace Boiler Installations.

Delaware Power & Light Co.
Delaware City Power Station
3 Units — 500,000 lbs/hr each
1425 psig — 950F Fuel — Fluid Coke

Texas Electric Service Co.
Permian Basin Steam Elec. Station
1 Unit — 825,000 lbs/hr
1750 psig — 1005/1005F
Fuels — Gas, Oil, Future Coal

Dallas Power & Light Co.
Northlake Steam Elec. Station
2 Units — 1,200,000 lbs/hr each
2125 psig — 1005/1005F
Fuels — Gas, Oil, Future Coal

Louisiana Power & Light Co.
Sterlington Steam Elec. Station
1,550,000 lbs/hr
2125 psig — 1005/1005F
Fuels — Gas, Future Oil, Coal

Louisiana Power & Light Co.
Little Gypsy Steam Elec. Station
1,650,000 lbs/hr
2125 psig — 1005/1005F
Fuels — Gas, Oil

Florida Power Corporation
Turner — Unit No. 4
600,000 lbs/hr
1750 psig — 1000/1000F
Fuels — Gas, Oil

New Orleans Public Service Co.
Michoud — Unit No. 3
1,550,000 lbs/hr
2325 psig — 1005/1005F
Fuels — Gas, Oil, Future Coal

Manila Electric Co.
Rockwell Station — Units 6, 7
430,000 lbs/hr each
2160 psig — 1005/1005F
Fuel — Oil

RILEY

STEAM GENERATING & FUEL BURNING EQUIPMENT

A careful survey of your plant by a qualified consulting engineer could show ways of making substantial savings in power costs.

RILEY STOKER CORPORATION • WORCESTER, MASSACHUSETTS

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HERE'S WHY BEACON COAL

WHEN—WHERE—

Name of Coal	Character	Mine	Seam	County & State
Sonman	Central Pennsylvania Low Volatile	Sonman	"E"	Cambria (Pa.)
Colver		Colver	"B"	Cambria (Pa.)
Indian Creek	Central Pennsylvania Medium Volatile	Melcroft	"B" or Miller	Fayette (Pa.)
Federal	Northern West Virginia	Federal #1	Pittsburgh	Marion (W. Va.)
Beckley	Southern West Virginia Low Volatile	Eccles #5	Beckley	Raleigh (W. Va.)
Sewell		Eccles #6	Sewell	Raleigh (W. Va.)
New River		Stotesbury #8	Pocahontas #4	Raleigh (W. Va.)
		Stotesbury #10	Pocahontas #4	Raleigh (W. Va.)
		Stotesbury #11	Pocahontas #4	Raleigh (W. Va.)
Pocahontas		Keystone	Pocahontas #3	McDowell (W. Va.)
Eagle	Southern West Virginia and Eastern Kentucky High Volatile	Beards Fork	Eagle	Fayette (W. Va.)
		Kopperston #1	Eagle	Wyoming (W. Va.)
No. 2 Gas		Kopperston #2	Campbells Creek	Wyoming (W. Va.)
Wharton		Wharton #1	Hernshaw	Boone (W. Va.)
		Wharton #2	Hernshaw	Boone (W. Va.)

As this chart shows, there is a Beacon Coal suited to every fuel need. Domestic or Commercial, Hand or Stoker Fired; General Industrial, Electric Utility, Railroad, Coke or Gas Plants; and Special Uses. Mine Locations and shipping facilities permit speedy, efficient delivery, and conveniently located sales offices (map). That there's a Beacon Representative ready, as always, every area, to serve you.

If you would like a copy of this chart for reference—just write or phone the office nearest you.

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EASTERN

PITTSBURGH
Koppers Building

CAN GIVE YOU THE COAL YOU NEED

AND AS YOU NEED IT

Railroad	District	Sizes Made	Daily Prod. Tons	Name of Coal
Penna.	1	Egg; Stoker; M/R; N&S; Slack	2500	Sonman
C & I	1	N&S; Slack; Stoker; Nut	5000	Colver
B & O	1	M/R; N&S; Slack	1200	Indian Creek
Monongahela; B&O	3	Lump; Egg; Nut; Stoker; M/R N&S; Slack	12,500	Federal
C & O; N & W	7	Scr. M/R; Stove; N&S; Slack	2500	Beckley
C & O; N & W	7	Scr. M/R; Stove; N&S; Slack	1000	Sewell
C & O; N & W	7	Stoker; M/R; Slack	2000	New River
C & O; N & W	7	Stoker; N&S; Slack	2500	
N & W	7	M/R; Slack	1800	
N & W	7	Egg; Stove; Nut; Stoker; M/R; N&S; Slack	7500	Pocahontas
N & W	7	M/R; N&S	2900	Eagle
N & W	8	M/R; N&S; Slack	3500	
N & W	8	M/R; Nut; N&S; Slack	7000	No. 2 Gas
C & O	8	M/R; N&S	3500	Wharton
C & O	8	M/R; N&S	4000	

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BOSTON
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CLEVELAND
Terminal Tower Building

DETROIT
[illegible] Suffield Road
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NEW YORK
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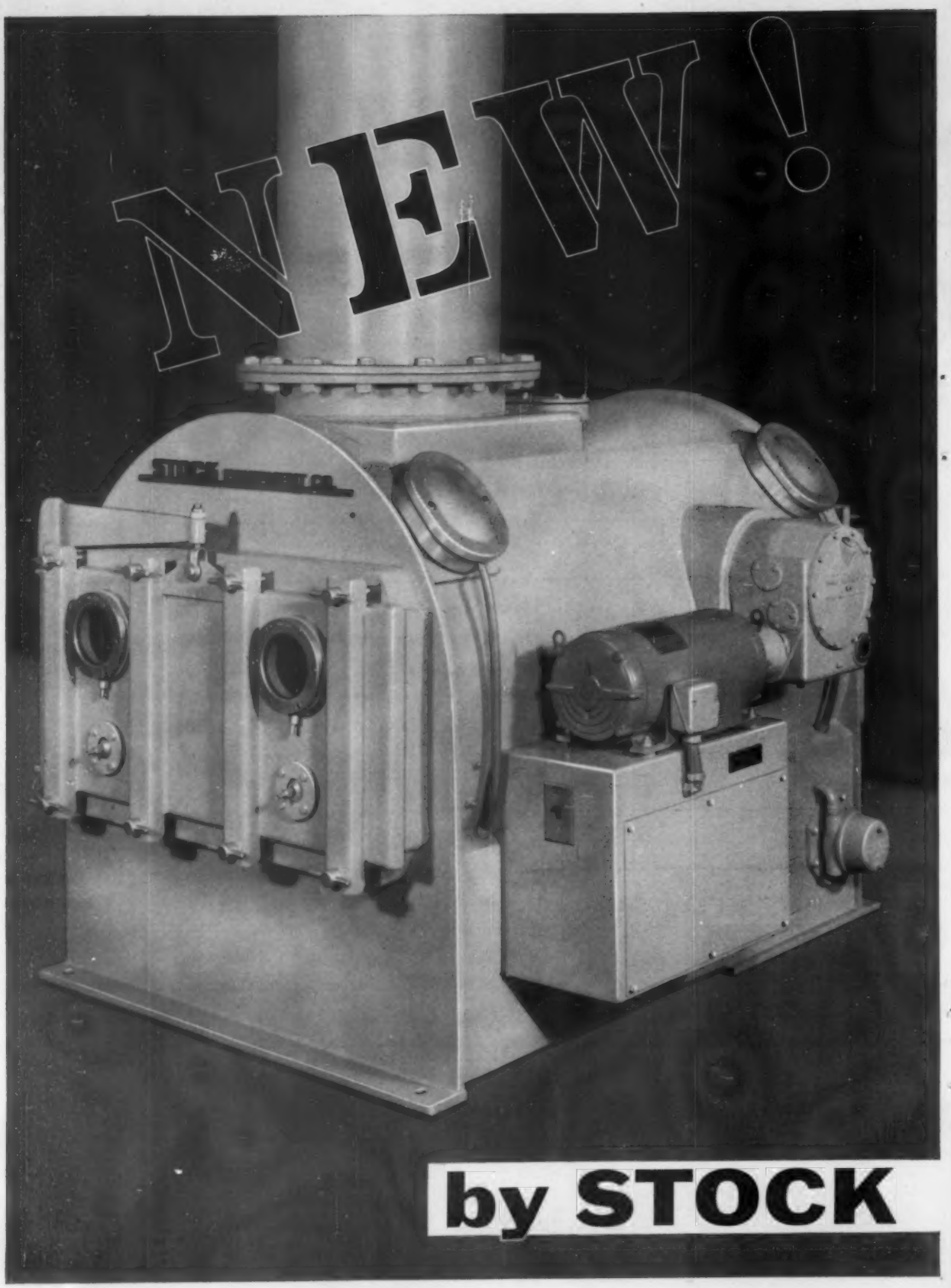
NORFOLK
[illegible]

PHILADELPHIA
Suburban Station
Building

SYRACUSE
State Tower Building

For New England: NEW ENGLAND COAL & COKE CO.
For Export: GARDNER CURRAN & BULLITT, INC.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announces

a New Volumetric Feeder for Short Center Installations

Outstanding Features:

- Endless belt
- Unobstructed 24" width of coal
- Large depth of coal to enable passage of occasional large pieces or frozen lumps of coal
- Curbs along edges of belt
- Variable speed drive utilizing magnetic slip clutch
- 50 psi explosion pressure housing for feeding pulverizers
- Belt change easily completed in 20 minutes
- Lights and bull's-eyes
- Poke hole next to inlet
- Stainless steel bottom liner
- Swing switch at outlet to stop feeder in event of coal stoppage in downspout to pulverizer
- Swing switch at inlet as required
- Models available for pulverizers and cyclones
- Centerline of inlet to centerline of outlet 2'-8", standard
- Intermediate centers 3'-8", 4'-8", 5'-8" 6'-8", 7'-8".

Long Center and Gravimetric Feeders are also available.

For better feeding of coal to pulverizers and cyclones, write to

Equipment Company

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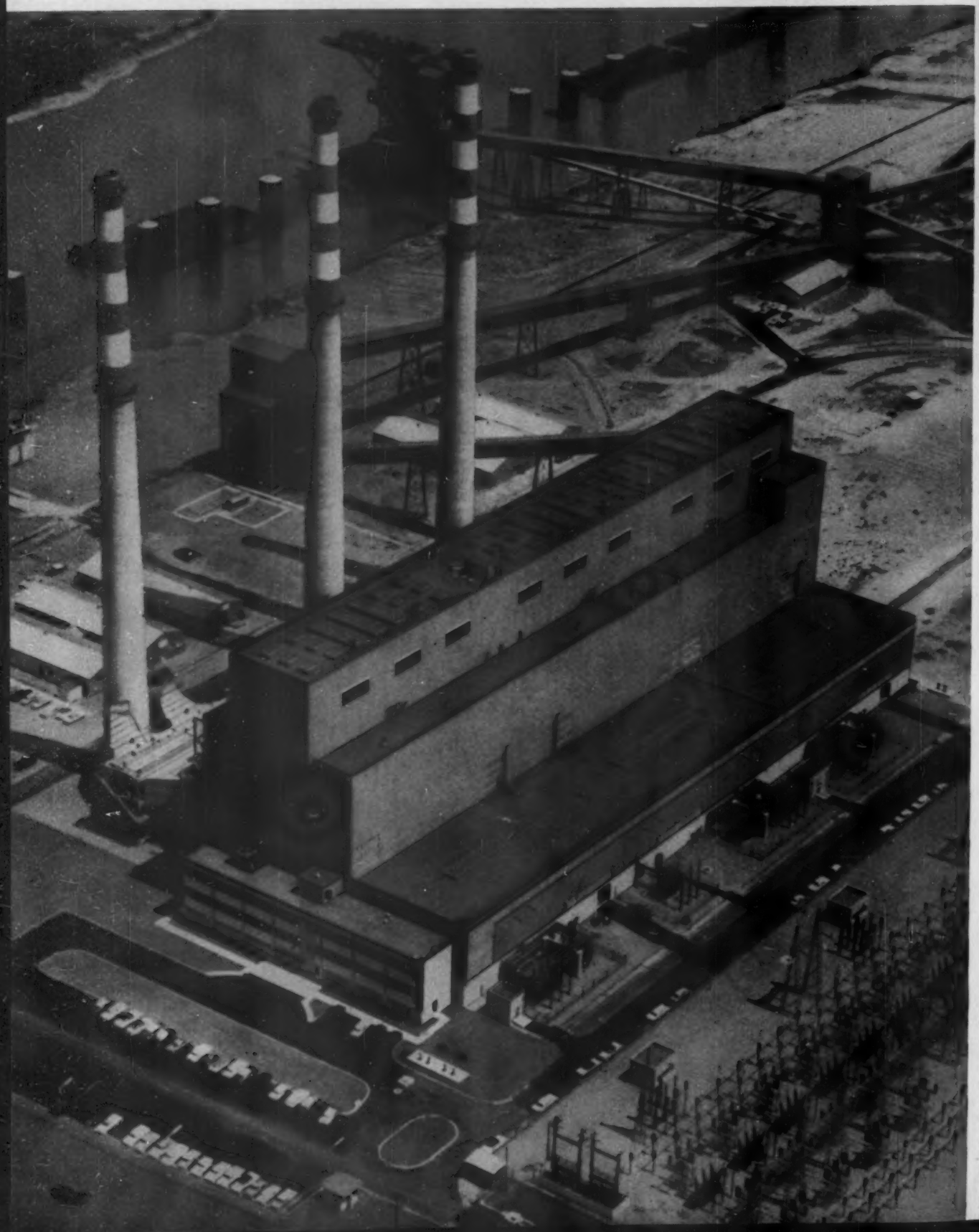
Thos. H. Allen Electric Generating Station,

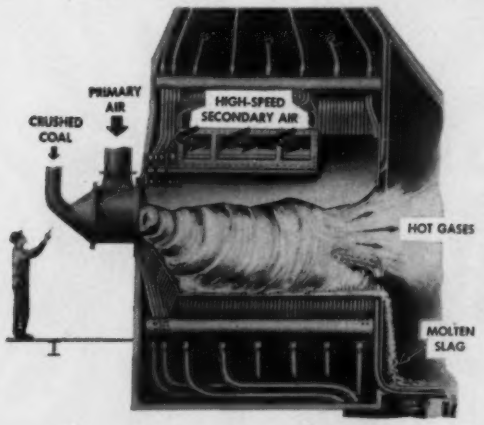


Memphis, Tennessee . . . 6 Million lb of Steam per hr

CONDITIONS:	
PRESSURE (TURBINE THROTTLE)	2400 psi plus overpressure
CIRCULATION	Natural Circulation
TEMPERATURE	1053F/1053F
FIRING	Cyclone Furnace
OTHER FEATURES	Gas Tempering

Natural circulation is self stabilizing over varied operation conditions at pressures of 2400 psi and higher—cuts boiler maintenance—no power loss to circulating pumps.

November, 1959, saw the third 2 million lb natural circulation boiler on the line in the Thos. H. Allen Electric Generating Station of Memphis, Tennessee. Although normally operated with 2400 psi at the turbine throttle, these units are capable, by design, of peaking operation at overpressure conditions for maximum kilowatt output as evidenced by actual test results. These units again demonstrate the advantages of natural circulation at the higher operating pressures and temperatures necessary for maximum power generating efficiency. Burning some 300 tons of West Kentucky coal hourly in 21 B&W Cyclone furnaces, the station has a net generating capacity of 812,500 Kw.



Cross section view of a B&W Cyclone Furnace. Molten slag holds coal and ash permitting rotary air motion to "wash out" maximum BTUs, and reducing ash in boiler and convection passes. The Cyclone Furnace handles a wider range of coals, especially in the lower grades, and helps reduce fuel-costs and ash handling in power stations across the nation.

Use of natural circulation—which is self-stabilizing under conditions of sudden overload and fluctuations in firing—is possible in the high pressure, high temperature range through B&W's development of the Cyclone Steam Separator. It is this device that provides the steam free head of water for efficient functioning of the natural circulation system. With Cyclone Steam Separators, boilers functioning at the throttle pressures of 2400 psi and higher, provide more efficient operation plus operating and capital economies—factors underscored by carefully considered utility choice.

The City of Memphis' Thos. H. Allen installation is representative of advanced steam generating stations across the nation. Utilizing such B&W design advantages as natural circulation, the Cyclone Steam Separator, the Cyclone Furnace, and gas tempering—these stations are helping to meet the surging needs for electric power.

In planning system expansion, B&W can talk your language in terms of efficiency and future operating economies. You'll find B&W sales engineers ready to work with you at every stage of your planning. The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

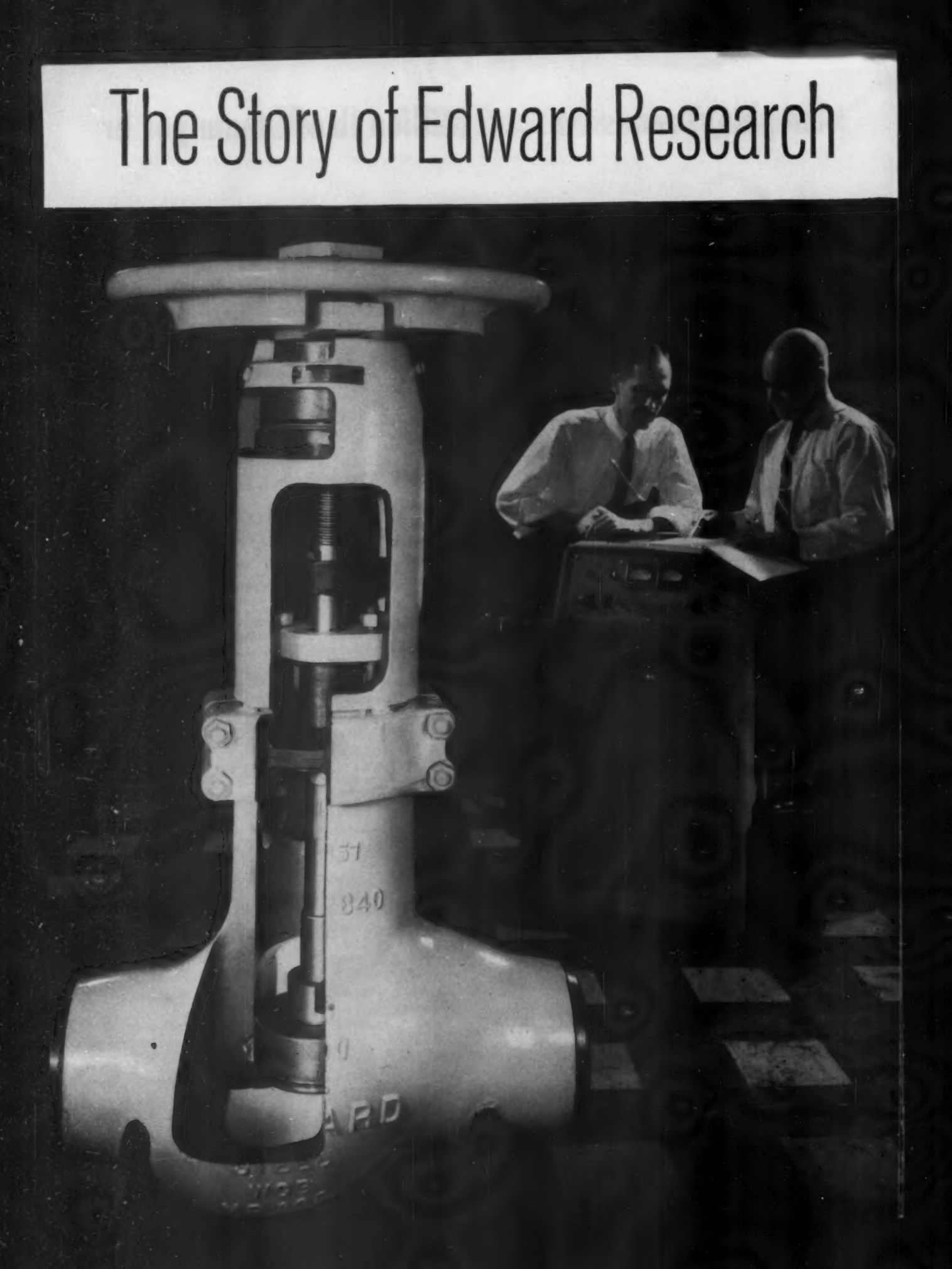
G-961-CS

B&W

THE BABCOCK & WILCOX COMPANY

BOILER DIVISION

The Story of Edward Research



and the Pressure-Seal* Valve

The introduction, in 1945, of commercial steel valves with pressure-seal bonnet joint construction was a significant advance in the art of building large high-pressure steel valves. The new pressure-seal construction eliminated massive flanged bonnet joint connections and made it possible to seal the valves permanently at high temperature. These advantages were immediately apparent to users everywhere. But bonnet joint leakage problems developed on the new valves in service. And Edward engineers soon became convinced that the original 45° pressure-seal gasket design used by Edward and others required improvement. Here's the Edward pressure-seal redesign story:

INITIAL TESTING—Edward engineers began their studies on leak problems in 45° gasketed pressure-seal valves by determining under what conditions the valves were most likely to leak. It was discovered that when sealing areas were thoroughly degreased and tested with air, the pressure seal would leak at all pressures above 10 psi. In addition, minute imperfections in the sealing area of the valve body bore were preventing intimate gasket contact and contributing to leakage. Edward engineers found that a broader area of contact between gasket and bonnet and between gasket and body bore would also reduce leakage. Further investigation showed that a gasket plating material softer than the silver plating previously used would be helpful in achieving better contact in the sealing area.

To obtain more gasket sealing area, experiments were conducted on gaskets with angles from 45° down to 17°. Over a period of several months, tests were made with 25 different combinations of gasket and bonnet angles and various gasket plating materials. Assembled valves were tested for tightness with air pressures ranging from 10 psi to 2160 psi, and at temperatures up to 1000 F for extended periods. And tests on ease of valve disassembly (an important user consideration) were made with each gasket combination.

TEST CONCLUSIONS—At the end of their extensive testing program on the pressure-seal design, Edward engineers were able to draw these conclusions:

1. 45° gaskets, which showed no leak on water tests, leaked air at similar pressures.
2. No gasket of any design, either plain or with a plating of 100 Brinell or harder, would seal air when assembled unlubricated.
3. The best sealing under test resulted with a 25° gasket angle which was 1° more acute than the bonnet angle.
4. Gaskets of 25° angle actually tripled the sealing surface area.
5. A stainless inlay in the valve body bore sealing area substantially improved gasket-to-body contact and provided a corrosion-resistant surface.
6. Gaskets of 25° angle, plated properly with a malleable coating, gave perfect air or steam sealing at all temperatures, whether assembled dry or with a lubricant.

NEW VALVE DESIGN—As the result of their tests, Edward engineers designed the completely new pressure-seal valve with 25°-65° joint (see diagram below). This change in gasket angle, with an increase in sealing surface area, and the addition of a special corrosion-resistant malleable coating, brought an end to bonnet joint leakage in Edward pressure-seal valves. And, since 1953, thousands of Edward pressure-seal valves have been installed in a great variety of services *without a single case of failure reported to date.*

The story of Edward research and the pressure-seal valve is typical of the kind of research progress and product leadership you can expect from Edward Valves. Edward builds a complete line of forged and cast steel valves from ¼" to 18" for industrial, marine, petroleum and technological services. For more detailed information, contact your Edward Representative, or write Edward Valves, Inc., 1202 West 145th Street, East Chicago, Indiana. Subsidiary of Rockwell Manufacturing Company. Represented in Canada by Lytle Engineering Specialties, Ltd., 438 St. Peter Street, Montreal.

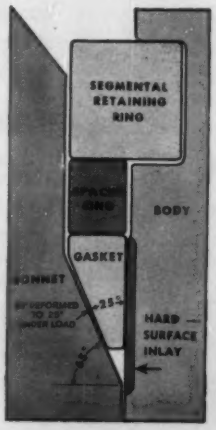
*Patented

EDWARD STEEL VALVES
another fine product by
ROCKWELL

P. J. DUKES, product development engineer, and D. MacGregor, works manager, are shown with helium leak detector used in testing pressure-seal valve joints.

SPECIAL GAS-FIRED FURNACES were used in temperature testing of new pressure-seal valve design. Furnaces heated valves up to 900 F for 24 hour periods. Pressure was maintained with hydro-pneumatic pumps.

NEW 25° GASKET DESIGN



accuracy

ASHCROFT DURAGAUGES measure pressure with precise accuracy no matter how severe the conditions of service

Ashcroft Duragauges are available in pressure ranges from 15 psi (or vacuum) minimum to 100,000 psi. Dial sizes: 4½" through 12".

sustained

The Bourdon tube in Ashcroft Duragauges is manufactured to precision standards of flexibility and mono-linked to the rotary movement. When pressure flexes the tube, the gauge pointer is always positively positioned, because it is mounted on the geared center shaft of the movement. Sustained high accuracy and long life are assured.

Choose your Ashcroft Duragauges made of components best suited to your needs. Eight Bourdon tube materials are available. Movement of stainless steel with nylon bearings and pinion gear for longest wear. Case materials: special aluminum alloy or tough phenol plastic.

The unique "Maxisafe®" Duragauge provides absolute protection to the viewer, plus easy and quick access to the mechanism. Your industrial supply distributor will help you select the best combination of components for your Ashcroft Gauge requirements. Phone him today or write for Catalog 300B.

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Only Morton offers salt service for water conditioning needs everywhere

Wherever your plant is located, whatever your needs may be, Morton, the only nationwide salt company, can supply the kind of salt and service necessary for top performance from your brinemaking equipment.

Morton Purex is a special high-purity evaporated grade of salt that is 100% soluble. Purex dissolves rapidly and uniformly, producing a clear, fully saturated brine at highest possible flow rates. Leaves no residue in brine storage chambers.

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Morton Solar Salt is available in extra coarse, coarse and medium grades and is recommended as an economical, high purity salt for use in West Coast water conditioning installations.

Mail coupon today for more information about the various grades of salt and the valuable service Morton offers the Water Conditioning Industry.

PLEASE SEND ME ADDITIONAL INFORMATION ON

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(type of salt)

I ALSO WOULD LIKE TECHNICAL HELP CONCERNING

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Safely interrupt fault currents up to 200,000 amperes...

Limit fault current to very low values

Hold 500% load for minimum of ten seconds

Buss Low Peak fuses can completely revolutionize the protection of the entire electrical system.

Protect Mains, Feeders, Branch Circuits, Motors, Controllers, Switches—no matter whether the fault current is 1,000 amperes, 25,000, 100,000—or as high as 200,000 amperes.

Reduce stresses and prevent damage to Panel-boards, Switches, Motor Controllers—other circuit components—because let-thru fault currents are limited to exceptionally low values.

Prevent work stoppages, lights out, waste of time and money—because long time-lag keeps them from opening needlessly on motor starting currents or other harmless overloads.

Permit increasing interrupting capacity and current limitation on present system at minimum cost.

Before designing a new installation—
or modernizing old installations—

GET ALL THE FACTS

Knowledge without action is of little value—but ACTION NOW may save you money—increase operating efficiency and reduce electrical hazards to a minimum.

BUSS LOW-PEAK fuses fit standard Switches and Panel-boards and are available in N.E.C. sizes from 15 to 600 amperes in both 250 and 600 volt ranges.

Write for BUSS LOW-PEAK Bulletin Now... or use coupon.

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PWE-660

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shop-assembled to 120,000 lb/hr capacity

Designed for Industry by

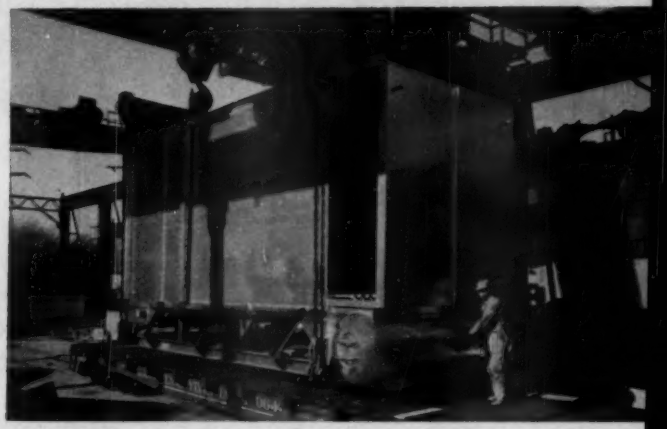
C-E shop-assembled boilers are available for a wide range of industrial, commercial and institutional applications. They are produced by the same C-E engineers who design the world's biggest and most efficient utility boilers—with capacities to 4,000,000 lb/hr and pressures to 5,000 psi. For the most economical solution to *your* steam or high-temperature water problems, write to C-E, outlining your requirements.

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS;

To 90,000 lb/hr . . . Type VP—A compact, economical, natural circulation, *package* boiler for the majority of industrial requirements. Steam capacities from 4,000 to 90,000 lb/hr; pressures to 700 psi; temperatures to 750 F. Most sizes shipped complete with firing equipment for oil or gas, setting and forced draft fan arrangement.

To 120,000 lb/hr . . . Type PCC—Shop-assembled *controlled circulation* boiler providing high output and high temperatures in a compact, high-performance unit. Capacities—80,000 to 120,000 lb/hr; pressures to 1,000 psi; temperatures to 900 F. Designed for minimum installation, operation and maintenance costs.

To 50,000,000 Btu/hr . . . Type HCC—High-temperature water boiler, shop-assembled, widely used for large-scale, economical heating of commercial and industrial installations—including many military air bases. Controlled circulation, pressurized oil or gas-fired from 10 to 50 million Btu; coal-fired to 40 million Btu. Field-assembled units to 300 million Btu.



To 50,000 lb/hr . . . Type WCC—Shop-assembled. Utilizes waste heat from open hearths or chemical processes. C-E controlled circulation design obtains big boiler performance from space-saving units. Capacities to 50,000 lb/hr—and up, depending on waste heat conditions—with pressures to 450 psi and temperatures to 750 F. Capacities of field-assembled units are virtually unlimited.

UTILITY-BOILER ENGINEERS

Write for catalogs—

C-E PACKAGE BOILER, TYPE VP

C-E CONTROLLED CIRCULATION PACKAGE BOILER, TYPE PCC

C-E CONTROLLED CIRCULATION HOT WATER BOILER, TYPE HCC

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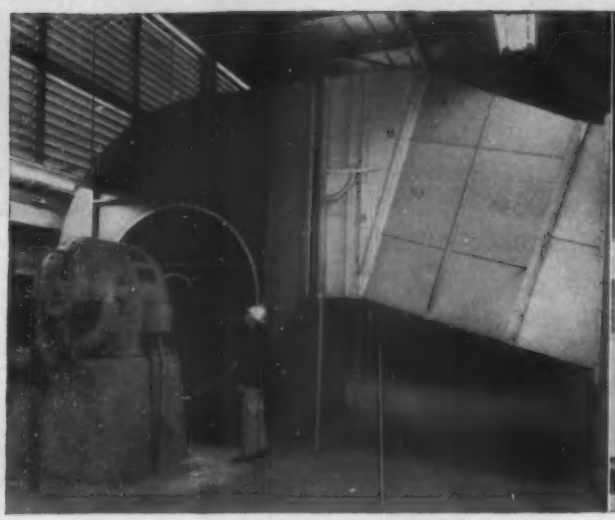
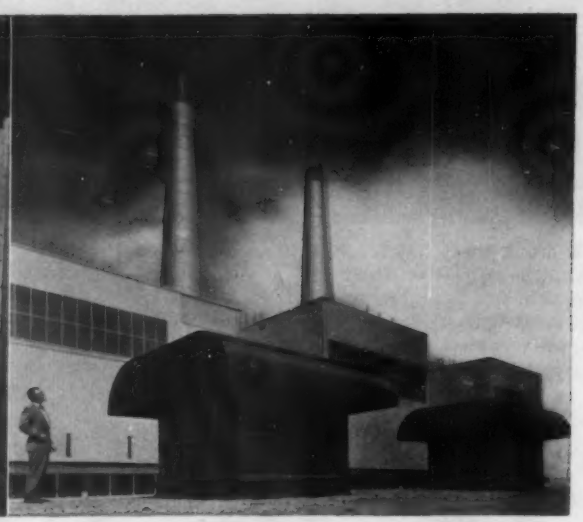
C-277

PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

How do you plan to ventilate and heat your power plant?



WITH CENTRIFUGAL FANS?



WITH POWER ROOF VENTILATORS?

Both methods have their advantages. The type fan you select will naturally depend on the circumstances encountered in the layout of your station. To meet these requirements, "Buffalo" offers power roof ventilators, centrifugal fans and make-up air units well suited to the task. Above are two typical "Buffalo" boiler room and turbine room ventilation installations.

"Buffalo" Centrifugal Fans — These quiet, efficient, non-overloading fans have proved an excellent choice for boiler house ventilation. If desired, hot air may be ducted to other areas as needed. "Buffalo" Centrifugal Fans provide completely stable performance from free delivery to shutoff. Turbulence is reduced to a minimum by unique "Buffalo" design features. All wheels are factory-balanced to minimize vibration. Rugged construction throughout gives a long life of trouble-free service. Write for full details in Bulletins F-104 and F-201.

"Buffalo" Power Roof Ventilators — These dependable "packages" exhaust high volumes of hot air from large areas. They save money from the start, because little, if any, expensive duct work is required. Peak-efficiency "Buffalo" fans insure minimum operating costs. Installation does not interfere with valuable floor space. "Buffalo" Sky-Vent Power Roof Ventilators are complete units, quickly and easily installed. Capacities 1,000 to 250,000 CFM. Assembled packages include fan, motor, housing, roof curbing, stack and hood. Can also be arranged for supply with heating coils and dampers. Write for Bulletin FM-2345.

Your nearby "Buffalo" engineering representative will be glad to work with you on your boiler room ventilation problems. Phone him today, or write us direct.

"Buffalo"

BUFFALO FORGE COMPANY Buffalo, New York
Buffalo Pumps Division, Buffalo, N. Y.
Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

VENTILATING • AIR CLEANING • AIR TEMPERING • INDUCED DRAFT • EXHAUSTING • FORCED DRAFT • COOLING • HEATING • PRESSURE BLOWING

For more data circle 516 on Post Card

MULTIPLY ECONOMY by 5

When You Install Buffalo Pumps

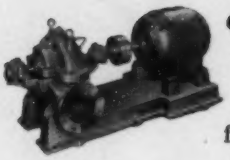
1 **Maximum parts interchangeability** reduces inventory costs.

2 **Emphasis on quality** insures extra years of economical, productive service.

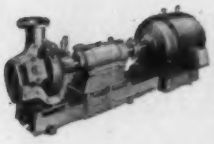
3 **Peak hydraulic efficiency** insures lower operating costs.

4 **Sturdy, extra-heavy construction** means trouble-free performance.

5 **Complete Buffalo line** gives one-source buying.



Clear Water Pumps. For peak efficiency in clear water service. Highest quality construction assures long, maintenance-free life. Write for Bulletin 955.



Non-Clogging Pumps. Efficiently move high consistency liquids. The diagonally split shell gives easy access for inspection. Rubber-lined models for moving abrasive or corrosive liquids. Send for Bulletin 953.

Heat Transfer Pumps. Specially designed to handle high temperature liquids. Construction includes required alloys, water-cooled bearings and packings suited to the job. High-efficiency single suction, solid shell design. Write for full information.

Chemical Liquid Pumps. These specially designed pumps stand up under the severest service, handle most types of corrosive or abrasive liquids. Choose from numerous models in exactly the trim you need. Send for Bulletin 976.

High Pressure Pumps. Designed for boiler feed and other clear water installations. These rugged pumps assure peak efficiency, minimum downtime and long life. Operate against heads to 1500 ft. Capacities to 900 gpm. For complete details request Bulletin 980.

Close-Coupled Pumps. Save space without sacrificing efficiency. Installation is simplified, no need for shaft alignment. Vertical or horizontal installation. Discharge adjustable to desired angle. Send for Bulletin 975.

Helping you select the pumps that will serve you best and most economically is your Buffalo Representative's job. Contact him today, or write us for complete facts.

BUFFALO PUMPS

Division of Buffalo Forge Company

529 Broadway **Buffalo, New York**

Buffalo PUMPS

Canada Pumps, Ltd., Kitchener, Ontario

Sales Representatives in all Principal Cities

A BETTER CENTRIFUGAL PUMP FOR EVERY LIQUID

For more data circle 517 on Post Card

Inspecting newly gunited concrete lining in precipitator at Consolidated Edison's Astoria Station, New York. **Contractor:** Research-Cottrell, Inc., Bound Brook, N. J. **Gunite Contractor:** J. A. McCollum, Inc., Marlton, N. J

Industrial concrete lining resists precipitator corrosion

Concrete linings of LUMNITE calcium-aluminate cement and aggregate are specified for power plant precipitators to protect against the corrosive effects of acid condensate and the abrasion of fly ash. Placement is fast, easy, economical – by guniting, pouring or plastering. Since the concrete reaches service strength within 24 hours, downtime is reduced. For greater convenience there are castables made with LUMNITE cement. These packaged mixtures, available from leading manufacturers of refractories, are ready to place when mixed with water. For more information, write Universal Atlas Cement, 100 Park Avenue, New York 17, N. Y.

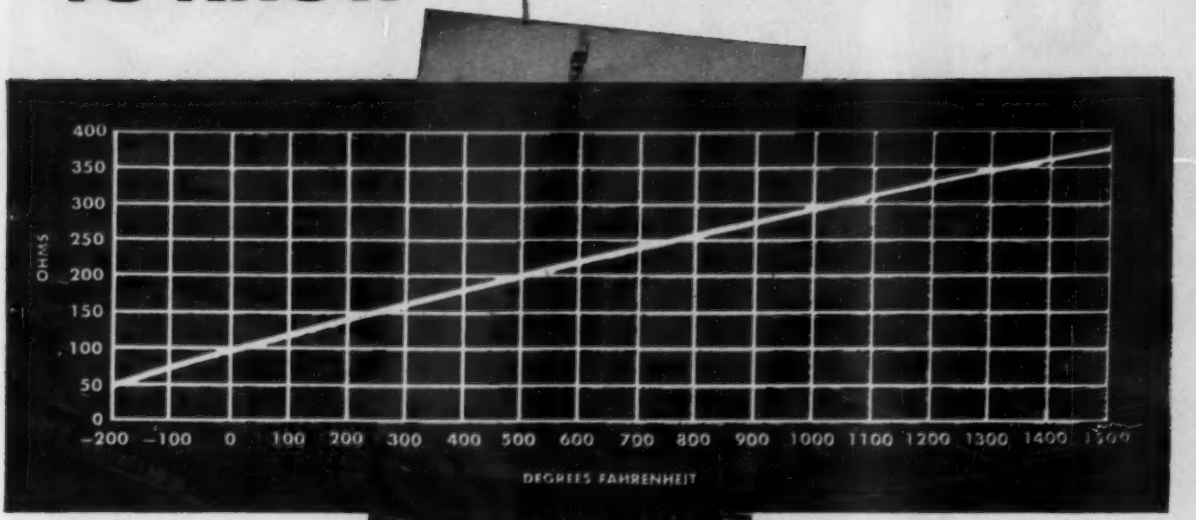
"USS," "Atlas" and "Lumnite" are registered trademarks L-207

Universal Atlas Cement
Division of
United States Steel

Offices: Albany · Birmingham · Boston · Chicago · Dayton · Kansas City · Milwaukee · Minneapolis · New York · Philadelphia · Pittsburgh · St. Louis · Waco

For more data circle 518 on Post Card

WHEN IT IS VITAL* TO KNOW



T/R Characteristics of Model 242P
Edison Resistance Temperature Detector

THE PRECISE TEMPERATURE

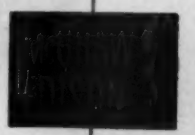
New manufacturing methods and new materials now enable Edison to offer a wide variety of Resistance Temperature Detectors for virtually any industrial temperature measurement. Edison RTDs indicate, record or control temperatures precisely and quickly, over a long period of years — without drifting, without maintenance and without errors due to ambient temperatures, stray elecrical fields, nuclear radiation, shock or vibration.

Because its principle of operation is based on the fact that the electrical resistance of metals increases with temperature, the Edison RTD is inherently accurate. Its accuracy is attested by the fact that in the temperature range of *minus* 300°F to *plus* 1220°F the platinum RTD is the International Temperature Scale. Since high-purity noble metals are used in the construction of Edison RTDs, they are extremely stable and reproducible. Their use in Wheatstone bridge circuits simplifies instrumentation by permitting the use of higher levels of power than is possible with either thermocouples or thermistors.

Standard detectors are available for use in the bearings of all types of machinery, to measure temperatures under nuclear radiation, on air compressors or in any chemical or petrochemical process. A wide variety of detectors for special purposes and for measurements to 1,800°F is also available from Edison, leader in the field.

Send for catalogue 3016 describing Standard Edison Temperature Detectors or send us your requirements for special detectors.

Thomas A. Edison Industries
INSTRUMENT DIVISION
37 LAKESIDE AVENUE, WEST ORANGE, N. J.



For more data circle 519 on Post Card

3 STORIES HIGH

200,000 sq. ft. condenser for Widow's Creek Station of TVA

or BROAD and LOW

YUBA CONDENSERS—with the most flexible tube bank layout in the industry—designed to fit any plant or space requirements

This is a three story high, twin-bank condenser—just one of many tube bank layouts possible with Yuba Condensers—most flexible in the industry. Whether you require a giant condenser or a small one, in a single or multiple pass or axial flow design—no matter what the size, type or service conditions, Yuba's flexible design paces the progress in the power industry.

Yuba's twin-bank tube layout, for example, permits turbine exhaust steam to flow unobstructed, with equal distribution throughout the entire tube bank with a free flow to bottom of condenser and into hotwell, where it reheats and deaerates condensate. In Yuba's deaerating condensers, the oxygen in the condensate is guaranteed to be less than 0.005 cc per liter. This design is patented.

For that extra performance, Yuba staggers the tube support plates—reducing harmonics—eliminating vibration. This is just another reason Yuba surface condensers have been installed all over the world in plants of many sizes. For full details, contact Yuba today.

Other Yuba products for steam power plants include Feedwater Heaters, Evaporators, Expansion Joints, Cranes, Tanks, Structural Steel and scores of other items.

YUBA

specialists in power plant equipment

YUBA HEAT TRANSFER DIVISION
4th and Main Streets, Honesdale, Pennsylvania

YUBA CONSOLIDATED INDUSTRIES, INC.

Sales Offices in Atlanta • Buffalo • Chicago • Cleveland • Houston • Los Angeles • New York • Philadelphia • Pittsburgh • San Francisco • Seattle

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HELPFUL BULLETINS

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 119 and 120.

INSTRUMENTS AND CONTROLS

101 Control Centers — Illustrated and described in 22-pp Bulletin C11 are control centers and systems for combustion safeguard and automation. Advantages of custom engineered control centers and systems are covered, and design data and starting sequence on nine typical installations included. Webster Engineering, Div. Midland-Ross Corp.

102 Automatic Controls — Selection and application information on a line of automatic controls for steam and water service is presented in this 46-pp Engineer's Manual. Covers controls for fuel oil heaters, heat exchangers for cooling, instantaneous heat exchangers, jacket water cooling, process hot water, pressure reducing, storage heaters, two temperature hot water systems. The Powers Regulator Co.

103 Pressure, Temperature Recorders — Eight-pp Catalog 800 describes design and construction features of pressure and temperature recorders. Illustrates pressure and temperature elements, lists materials and performance characteristics, and includes diagrams showing case dimensions, details of pressure and temperature connections. United States Gauge, Div., American Machine and Metals, Inc.

104 Fluid Meters — Operation, ranges, and installation requirements of company's fluid meters are included in 8-pp Bulletin 20. Integrators, compensators, and primary elements are also discussed. Bailey Meter Co.

105 Thermocouple Assemblies — Forty-pp Catalog G100–1 describes over 100 complete thermocouple assemblies in detail. Information provided includes specifications, dimensions, ordering tips and prices. Illustrated with product photos, catalog is divided into three major sections covering: general purpose assemblies, special use assemblies, and selection. Minneapolis-Honeywell Regulator Co.

106 Miniature Gages — Miniature vertical-type gages with 5-in. scales for measuring and indicating draft, pressure, differential pressure, temperature and pneumatic signals are described in 12-pp Bulletin 59–1. Shows such features as scales and ranges available, mounting dimensions and lighting details. Republic Flow Meters Co., Rockwell Mfg. Co.

107 Motor Operators, Valves — Catalog 407, 24 pp, describes company's electric motor operators and motorized valves, and introduces the new Type 2RD, a reversible, proportional unit with instant breaking. Fully illustrated with photos and diagrams, booklet covers features, construction details, applications, dimensions. Valves described include butterfly, rotary disc, balanced globe, three-way, fuel control, other types. Schade Valve Mfg. Co.

MECHANICAL POWER TRANSMISSION

108 Magnetic Drives — Performance data on magnetic drives designed to provide overload protection even under extended full stall are presented in 12-pp Bulletin TP 1–60. Drive features are described, typical application illustrated, and engineering selection method outlined. Tormag Products, Div., Gleason Reel Corp.

109 Motorized Reducers — Bulletin 3100, 28 pp, provides up-to-date information on the full line of all-steel Motoreducers in types to meet all requirements. Includes data on new Size E offering increased capacity but requiring little more space. Text and illustrations show how basic design permits maximum use of standardized parts and affords wide choice as to output shaft position, connection and speed, type of motor, mounting etc. Selection tables, capacity data, dimensions and weights are provided, also load classifications by industry and application. Also described are accessories and couplings. The Falk Corp.

110 Heavy Duty Transmissions — Standard transmissions customized to each application is the theme of this 8-pp bulletin describing heavy-duty transmissions with input torque capacities of 150 to 2500 ft-lb. Examples of standard single speed, multiple speed, and right-angle drives are illustrated with complete lists of input torque capacities, speeds, and gear ratios. Cotta Transmission Co.

111 Variable Pitch Sheaves — Eight-pp Bulletin SL-101-A illustrates and describes spring loaded and manually controlled type variable pitch sheaves and adjustable motor bases. In addition to specifications, it contains tables of practical stock drive combinations for convenient selection. Browning Mfg. Co.

112 Power Transmission Belting — Advantages and applications of varied types of belting for V-drives, positive drives and variable speed drives are detailed in 24-pp Catalog B-60. Explains difference in design and construction between V-belts with synthetic cord load carrying sections and steel cable load carrying sections, discusses the respective places of positive drive belts and variable speed belts in modern power transmisson, and includes detailed selection data. Maurey Mfg. Corp.

113 On Aluminum Bearings — "Alcoa Aluminum Bearings," 90 pp, presents a recent and extensive collection of case histories, engineering and test data pertaining to sleeve bearings and bushings of aluminum. The art and science of designing bushings — from the miniature to the gigantic 4-ft diam units — is discussed. Ten case histories, detailing both common and exceptional applications, preface the sections of engineering data. Liberal use is made of charts, graphs, drawings and photos in the technical sections. Aluminum Co. of America.

BOILERS, HEAT EXCHANGERS

114 Sectional Test Boilers — Features and advantages of company's test boilers for high temperatures and high pressures are detailed in this product bulletin. Installed in the nuclear N.S. Savannah for supplying start-up and supplementary steam, unit described has applications for standby or auxiliary operation in power plants. Condensed specifications included. Besler Corp.

115 Heat Exchangers — Engineering Manual PB-EM102-A contains 22 pp of illustrations, cutaways, diagrams and design data on Polybloc impervious graphite heat exchangers, corrosion-resistant, high thermal conductivity units. Contains charts, graphs, typical calculations, examples and specifications. Covers principles of operation. The Carbone Corp.

VALVES, PIPING, FITTINGS

116 Valve Data — Catalog 10-A contains 16 pp of information on bronze, iron and forged steel gate valves, bronze and iron globe and angle valves, bronze and iron check valves, asbestos packed iron cocks, bar stock valves, valve parts, steel and forged valve accessories, and cast steel valves. Operating specifications, characteristics, sizes, ratings and illustrations are included. R-P & C Valve Div., American Chain & Cable Co ., Inc

117 Check Valves — Applications, engineering features, operating principles, dimensions and weight reduction of one-piece cast steel tilting disk check valves are discussed in Catalog 14-Y, 12-pp. The valves are suggested for all welded conventional and nuclear piping systems in 900-, 1500-, and 2500-lb pressure classes, sizes from 6 to 20 in. Catalog includes ratings, flow index table, curves, test results, and valve material specifications. Edward Valves, Inc.

118 Corrosion-Resistant Valves — This 8-pp guide lists relative ability of metals, plastics and synthetic rubbers used in Flo-Ball valves to resist corrosive effects of 390 fluids encountered in industry. The tabulation permits a rapid estimate of the effects of these fluids on selected materials of construction — aluminum, carbon steel, semi-steel and 316 stainless; Buna N, Neoprene and Viton A; Teflon, nylon and Kel-F. Hydromatics, Inc.

119 Diaphragm Control Valves — Sliding gate diaphragm control valves designed for instrumented process systems requiring linear flow characteristics and tight shut off are illustrated and described in 8-pp Bulletin J-170. Cutaway views showing component features are included, as well as tables of dimensions and recommended capacities. OPW-Jordan.

120 For Fluid Flow — Eight-pp Bulletin 5911251 describes valves for fluid flow and condition control. Details such design and selection factors as function, application, and method of actuation, and gives

engineering data, characteristics, range specifications and illustrates various types of valves. United Aircraft Products, Inc.

121 Unions and Valves — Detailed information on company's line of pipe unions and swing check valves is presented in 18-pp Catalog 60. Includes engineering data, weights and dimensions, and describes convertibility feature of standard weight hot forged steel pipe unions. Catawissa Valve & Fittings Co.

122 Supports for Piping — Described in 96-pp Catalog 59 is a system utilizing pre-engineered standard components in almost infinite combinations to solve most piping and equipment support problems. The system affords savings in engineering and field costs, eliminates detailed hanger drawings and offers simplicity of use. Book also gives details on constant support hangers; roller devices; variable supports; light duty and cushion-spring hangers, sway braces; standard assembly parts and hardware; hanger assemblies. Bergen Pipesupport Corp.

123 Piping for Nuclear Age — This manufacturer's facilities for fabrication and erection of critical piping for the nuclear age, and for manufacturing welding fittings for nuclear piping systems are described in 24-pp Bulletin 60-A. Many installations are illustrated, including the Dresden Nuclear Power Station, the AEC Manhattan Project at Oak Ridge, atomic-powered ships, others. Midwest Piping Co., Inc.

124 Trap Strainers — Eight-pp Bulletin 601 contains a chart listing case histories of typical trap strainer applications. Strainer size, materials of construction, metallic straining media, housings, screens, flanges, and connections for specific applications in a variety of industries listed. Multi-Metal Wire Cloth Co., Inc.

125 Guide to Strainers — Presented in this 88-pp handbook on strainers is a compilation of reference data for layout of fluid flow systems and sizing of strainers, tabulated results of testings, and valve and pipe selection information. Reference material for each strainer section is on a fold-out page for use with any specific page in that section. The book contains over 100 illustrations of pressure drop, temperature, and viscosity charts in addition to engineering drawings. Tate Engineering, Inc.

HOSE, COUPLINGS

126 Improved Pressure Hose — Form NEPR-500, 25 pp, describes Hytron hose and couplings, described as a new concept in pressure hose performance attained with all-synthetic Hytron. A section on engineering facts on this hose covers its advantages, applications, limitations. Booklet also gives ordering and assembly instructions, tips on installation, chemical resistance tables, temperature and pressure ranges. The Imperial Brass Mfg. Co.

127 Industrial Fire Hose — Physical and chemical properties of industrial fire hose jacketed with Dacron are detailed in 12-pp Bulletin D-115. Tables of chemical exposure tests are included. E. I. du Pont de Nemours & Co.

INSULATION

128 Insulating Materials — Properties and specifications of over 30 heat and cold insulations for service from subzero to 1900 F are presented in this 24-pp 1960 catalog. Spun mineral wool, calcium silicate, and 85 per cent Magnesia products in block, blanket, felt, fill cement, and pipe insulation are described. Thermal conductivities and tables of recommended thicknesses are given. A selection chart, indicating temperature range of all included types of material, is provided, along with illustrations of typical installations. Baldwin-Ehret-Hill, Inc.

129 Pipe-Fitting Insulation — Design features and advantages of an improved molded Fiberglas pipe fitting insulation, are detailed in Bulletin TD-105. Specifications and dimensional data included. Fibrous Glass Products, Inc.

130 Underground Piping Insulation — Advantages and characteristics of Insul-Fil, a granular insulation for underground steam lines, are detailed in eight data sheets. Application details are illustrated and described and complete specifications included, as well as engineering drawings and graphs for determination of heat loss. Insul-Fil Co., Inc.

131 Surface-Coating Insulation — Properties and uses of Limitrak, surface-coating insulating material for electrical equipment, are detailed in 8-pp Booklet MB-1908-A. Covers physical and electrical properties, chemical resistance to various materials, its arc and track resistance. Westinghouse Electric Corp.

PUMPS, COMPRESSORS

132 Wet Pit Pumps — Featured in 6-pp Form 7209-A are vertical, wet-pit circulating pumps for large capacity pumping requirements. Includes external and cross-sectional views with detailed design features, typical installation views as well as sectional drawings showing dismantling details. Hydraulics Div., Ingersoll-Rand Co.

133 Centrifugal, Turbine Pumps — Features and advantages of centrifugal and turbine type pumps, single and multiple stage, flexible and close coupled, horizontal and vertical, are detailed in this product bulletin. Covers typical applications and includes capacity and head range for each type of pump — turbine, non-clog, split-case, sump, and suction and condensate return units. Aurora Pump Div., The New York Air Brake Co.

Postage-free cards for ordering catalogs are on page 119. You may also use the cards to order literature mentioned in the ads.

134 110 Psi Air Compressors — Bulletin 185, 12 pp, presents company's Balanced/Opposed air compressors for standard 110 psi industrial applications. Describes details of the compact heavy-duty design: Balanced/Opposed cylinders; rugged crankcase and compressor cylinder construction; overhung rotor, three- and five-step unloader controls etc. Specifications cover all 23 models (including units for soot blowing). Strokes range from 6 to 17 in., sizes from 75 to 2000 hp. Clark Bros. Co.

135 Industrial Equipment — Standard reciprocating, axial-flow and centrifugal air compressors, centrifugal pumps, steam condensers, steam-jet ejectors, vacuum pumps, air hoists, and air and electric tools are featured in 8-pp Bulletin Form 223. Illustrates representative machines in each product line and includes size and capacity ranges. Ingersoll-Rand Co.

PACKINGS, GASKETS, SEALS

136 Packings, Gaskets — Palmetto gasketing and gaskets for flanges, joints, boiler manholes, furnace doors and similar applications are described and illustrated in 12-pp Catalog GG-1259. Sectionalized for easy reference, catalog presents 14 types of sheet packings; compressed asbestos ring and full face gaskets; wire inserted folded asbestos gaskets; six types of tape, rope, lagging and wick packings. Provides details on composition, temperature limits and intended services, plus tabular listings on thicknesses, lengths, weights, prices. Greene, Tweed & Co.

137 Metallic O-Rings — Advantages of self-energized metallic O-rings designed to meet extreme conditions of temperature, pressure and corrosion are detailed in 30-pp Bulletin 596191A. Illustrates and describes applications, sealing characteristics, and includes recommendations for correct use, and tables of dimensions. United Aircraft Products, Inc.

138 O-Ring Handbook — Catalog 5711 is a 24-pp design and data book on Viton O-rings. Contains test information on some 150 fluids and gases to which this synthetic elastomer is compatible; recommended design techniques; general information on three compounds and dimensions; and data on all standard sizes. Among technical material provided are do's and don'ts regarding Viton O-rings, compression set graph. Parker Seal Co.

ENGINES, GAS TURBINES

140 Natural Gas Engines — Applications of natural gas engines in drill rigs, gas compressor, pipeline, air conditioning, sewage disposal, gas separation, electric, standby and other installations are detailed in 8-pp Booklet 20173. Includes basic specifications for natural gas engines, fuel consumption curves. Caterpillar Tractor Co.

141 Gas Turbine Power — Eight-pp Bulletin GEA-7083 introduces a line of 75- to 20,000-hp ultra-lightweight, compact gas turbines for a wide variety of applications, including fluid and gas pumping, electric power generation, and others. Covers design features, performance and operating characteristics, current and potential applications. General Electric Co.

142 Gas Turbines — The power concept of company's gas turbine based on the J-57 jet engine is discussed in 8-pp Bulletin 95. Describes operating characteristics, thermal efficiencies, maintenance costs, and potential applications, and includes schematic drawings, performance curves and engineering data. The Cooper-Bessemer Corp.

143 Standby Generator Sets — Illustrated and described in this 8-pp bulletin is a line of diesel powered standby generator sets for emergency power. Gives complete specifications on single and multiple-engine standby generator sets. General Motors Corp.

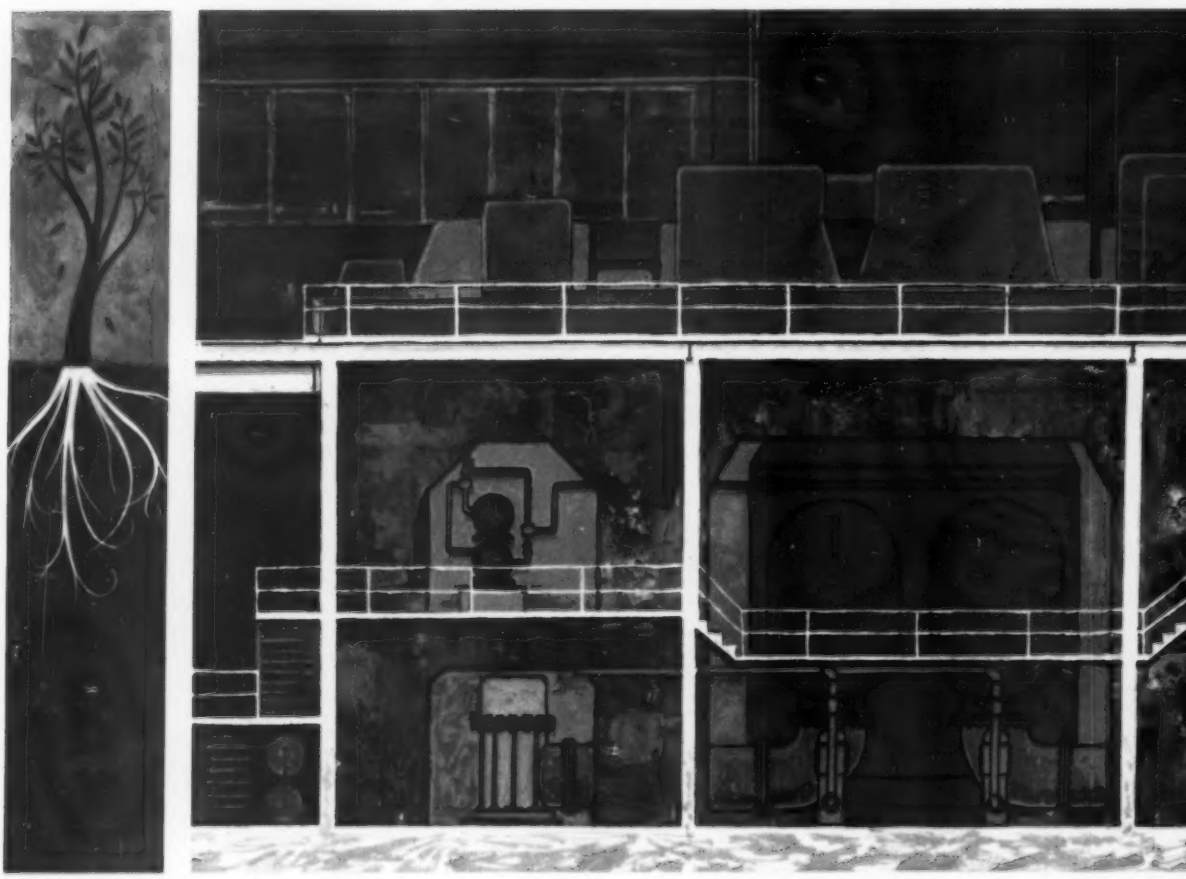
more Helpful Bulletins on page 119

American-Standard Industrial Division POWER-LIFT IN ACTION

surface co

WITH TOMORROW'S DESIGN IMPROVEMENTS TODAY

For the plant in your future you can plan with confidence using American-Standard surface condensers of today. They've made remarkable records of long, trouble-free life in producing design vacuum, zero degree depression hotwell temperature, and complete deaeration over a range of operating conditions—a result of many design improvements



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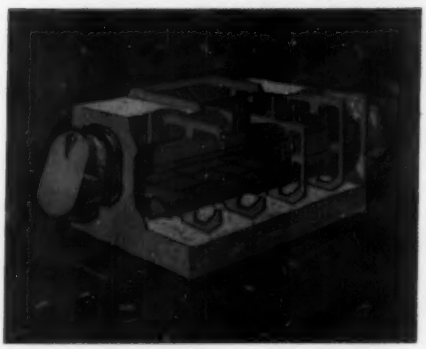
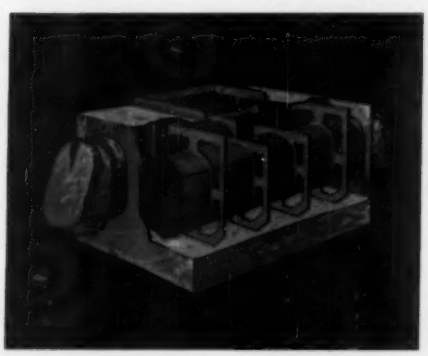
ondensers

and engineering features: Short steam path through tube bundle and improved steam distribution reduce pressure drop and assure top condensing efficiency of all tube surface. Pressurizing steam scoop traps inlet steam for deaerating hotwell. Hotwell deaerating trays further scrub condensate, completing deaeration and producing hotter feedwater. And new advance-design features reduce erection cost up to 65% over conventional methods.

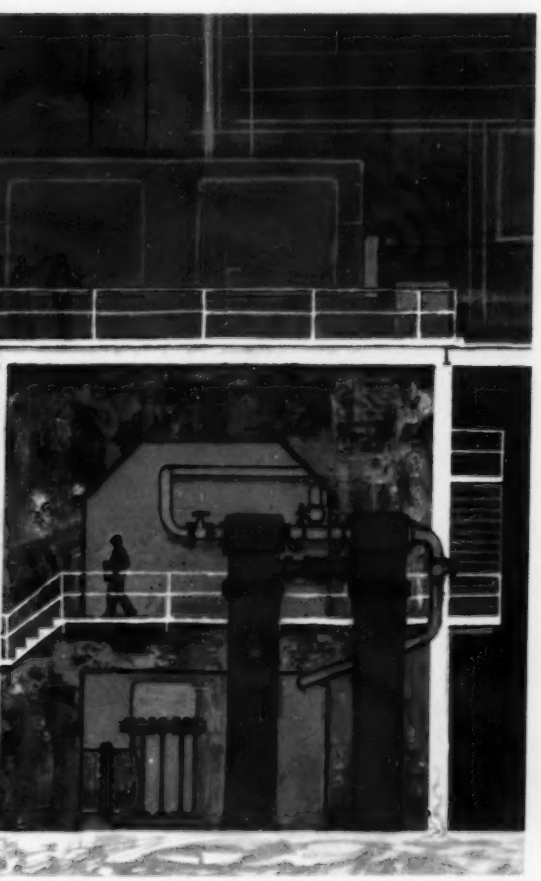
Moisture impingement grids extend tube life, and assure even distribution of steam.

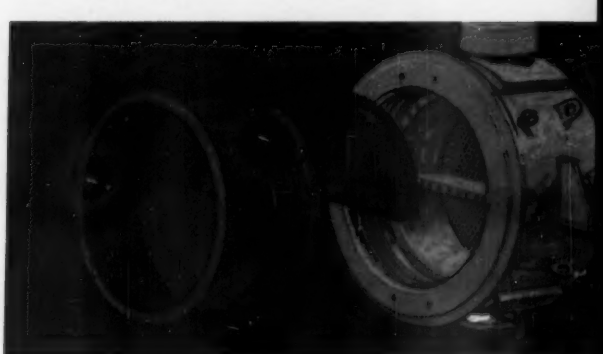


Condensate removal trays' unique location gives effective deaeration, higher vacuum.



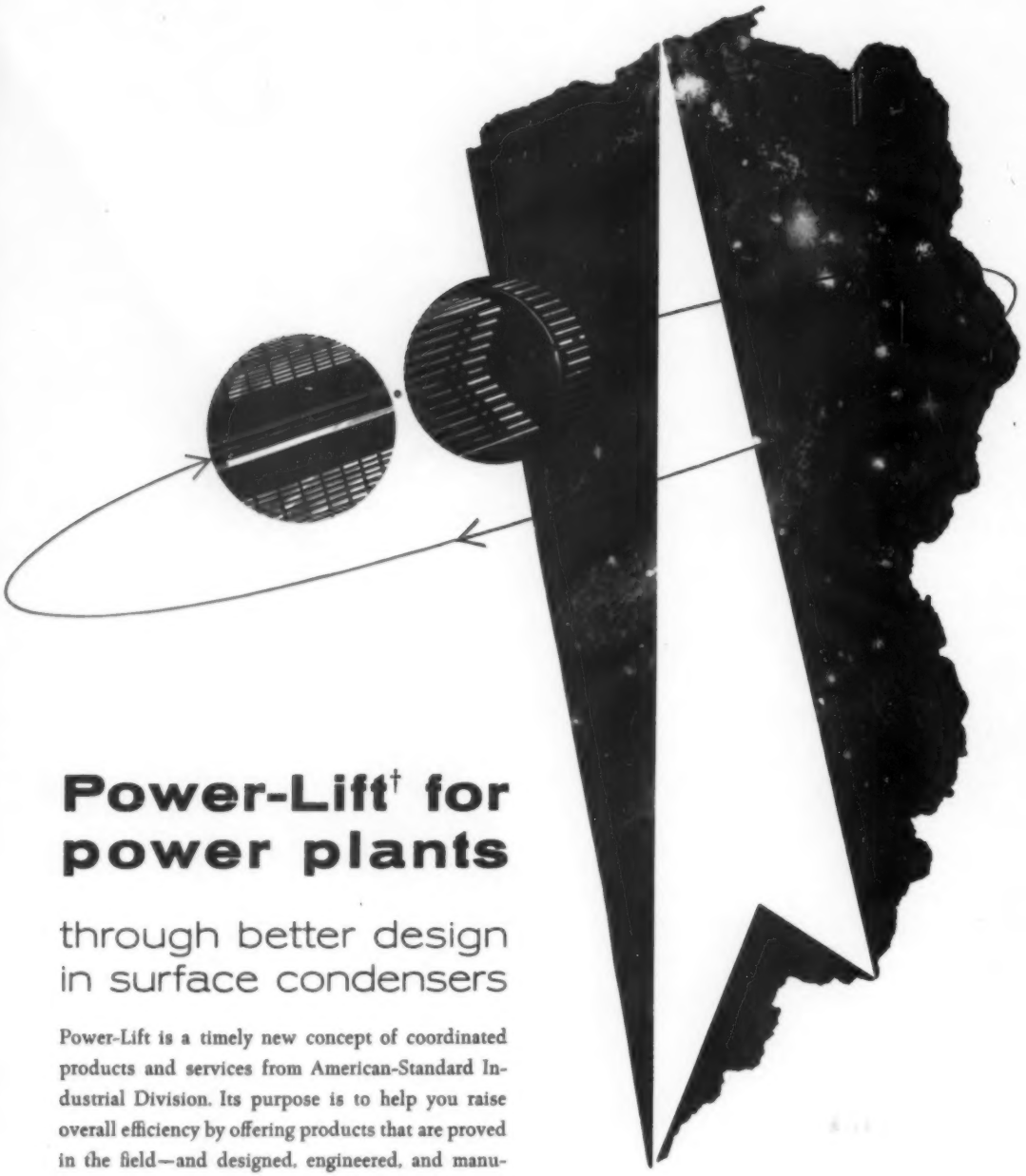
Extremely low bundle entrance velocity, exceptionally large steam transportation lanes.





American-Standard feedwater heater has a closure designed for ease of assembly and disassembly—which won't leak, even against highest operating pressures. It's simple, with only four major parts: pass partition plate, closure, seal, weld or compression ring. Rugged...design stresses are much lower than required by ASME Code. Compact, with a diameter smaller than similar units.

NEW FROM AMERICAN-STANDARD INDUSTRIAL DIVISION



Power-Lift† for power plants

through better design in surface condensers

Power-Lift is a timely new concept of coordinated products and services from American-Standard Industrial Division. Its purpose is to help you raise overall efficiency by offering products that are proved in the field—and designed, engineered, and manufactured to a uniform standard of quality and performance. American-Standard surface condensers, for example, have been continuously improved by development, research, and field experience over more than four decades. To see how their design improvements can benefit your plant operations . . .

†Service-mark of American Radiator & Standard Sanitary Corporation

Surface condensers

Mechanical draft fans

Feedwater heaters

lift the flap

As near as your phone . . . American-Standard Industrial Division Power-Lift Products and Services. Talk over your requirements with an American-Standard* Industrial Division product specialist. You'll find him well prepared and experienced—frequently able to base equipment recommendations upon precedents of proved success. And, in many instances, our comprehensive standardization paves the way to savings in time and cost. Offices in all principal cities. American-Standard Industrial Division, Detroit 32, Michigan. In Canada: American-Standard Products (Canada) Limited, Toronto, Ontario. Export Division, American-Standard, New York City.

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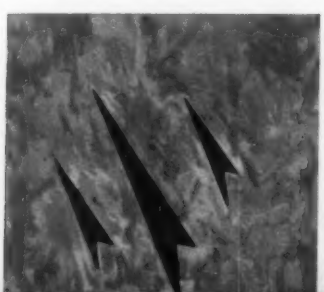

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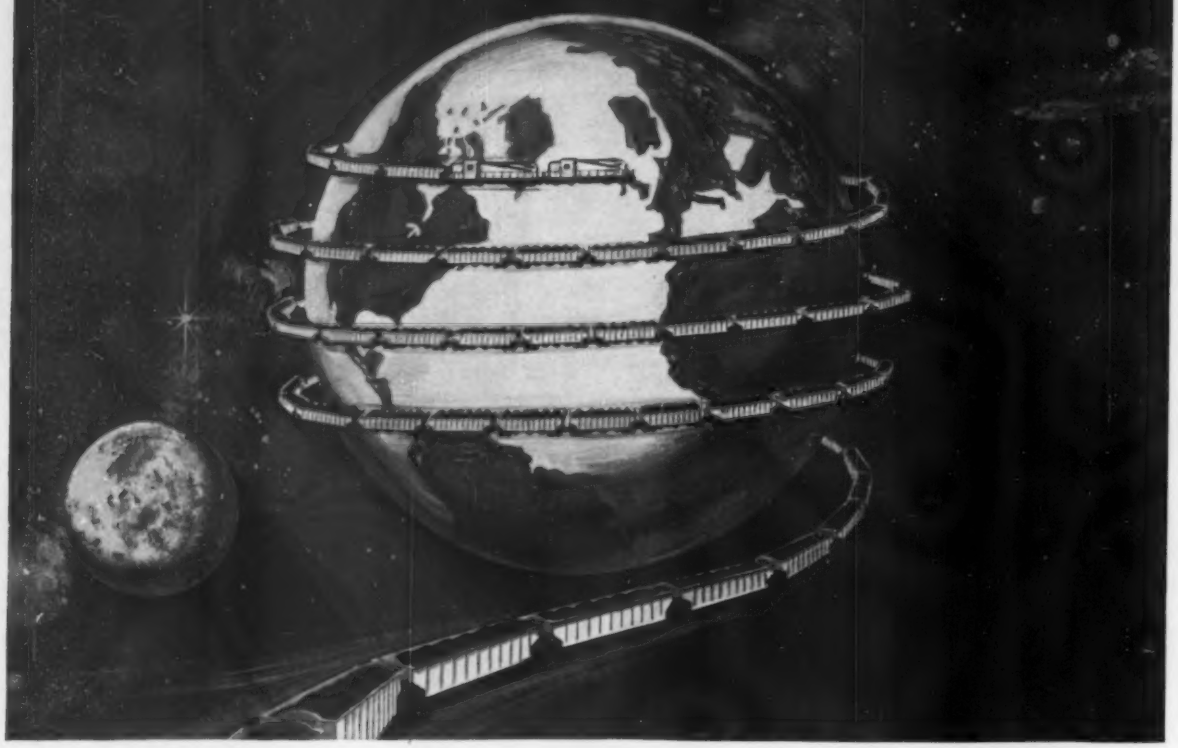

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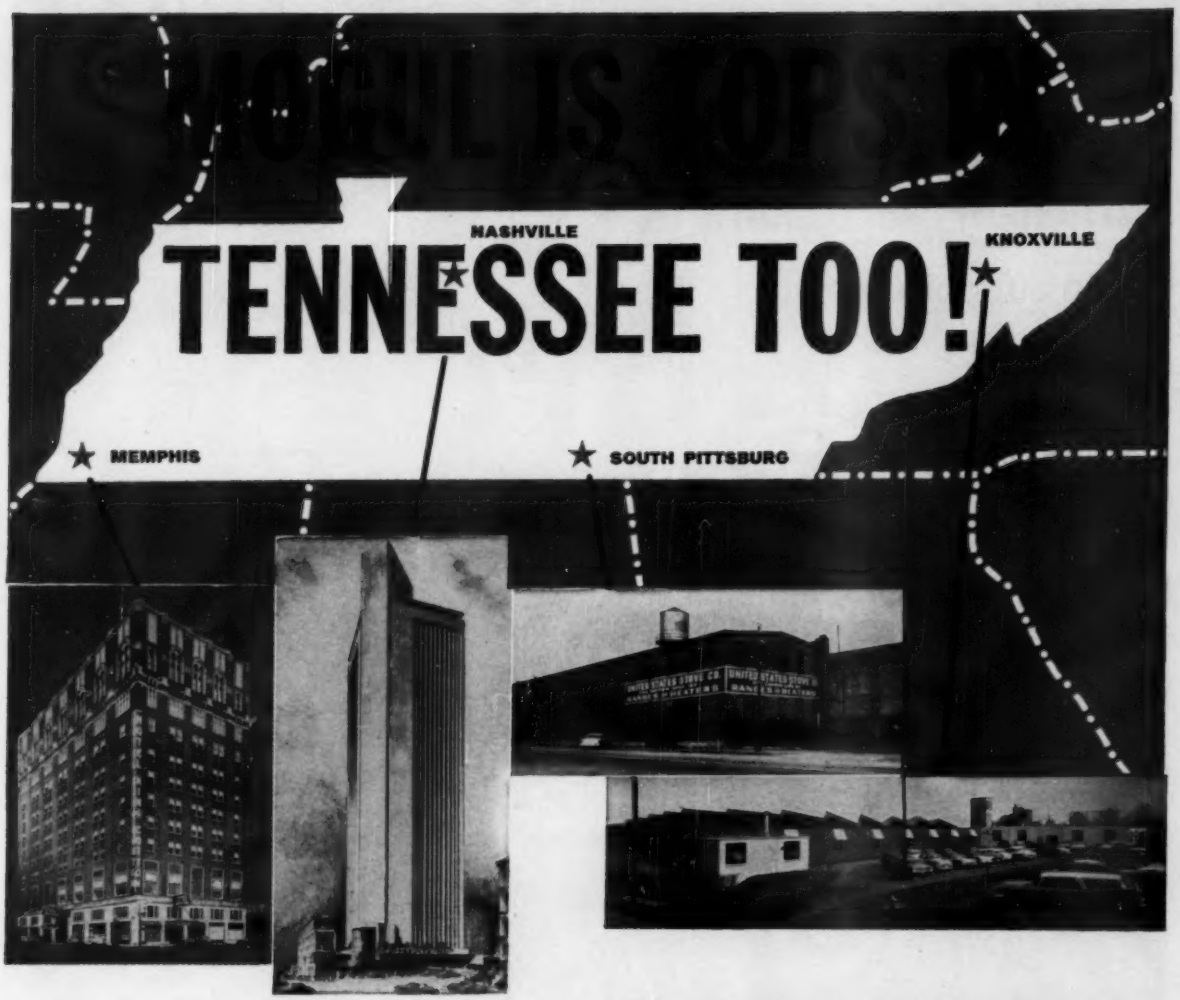

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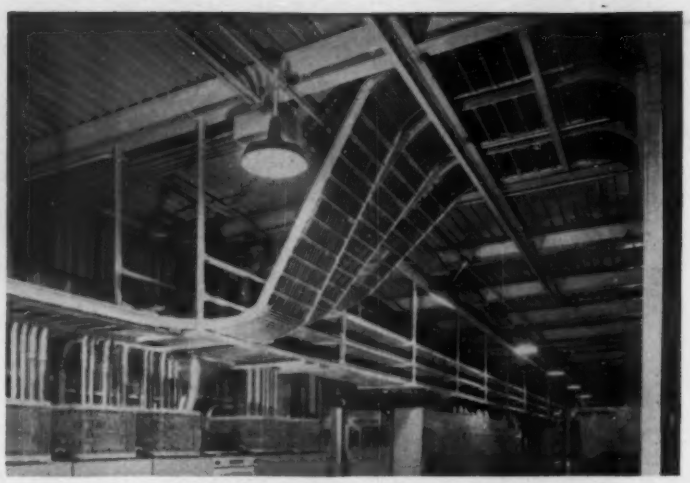

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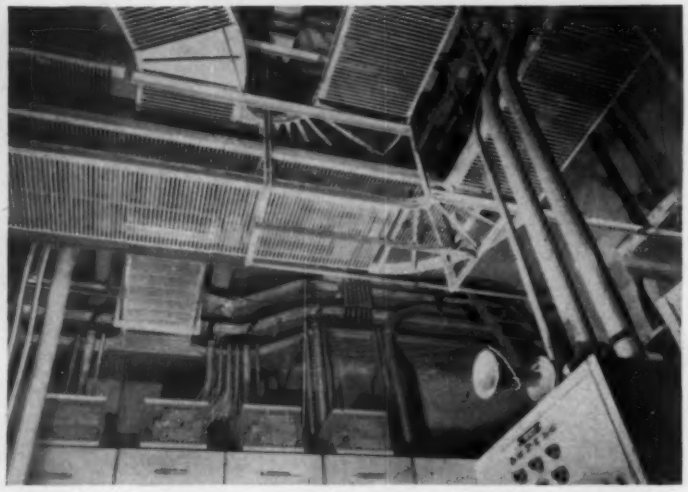

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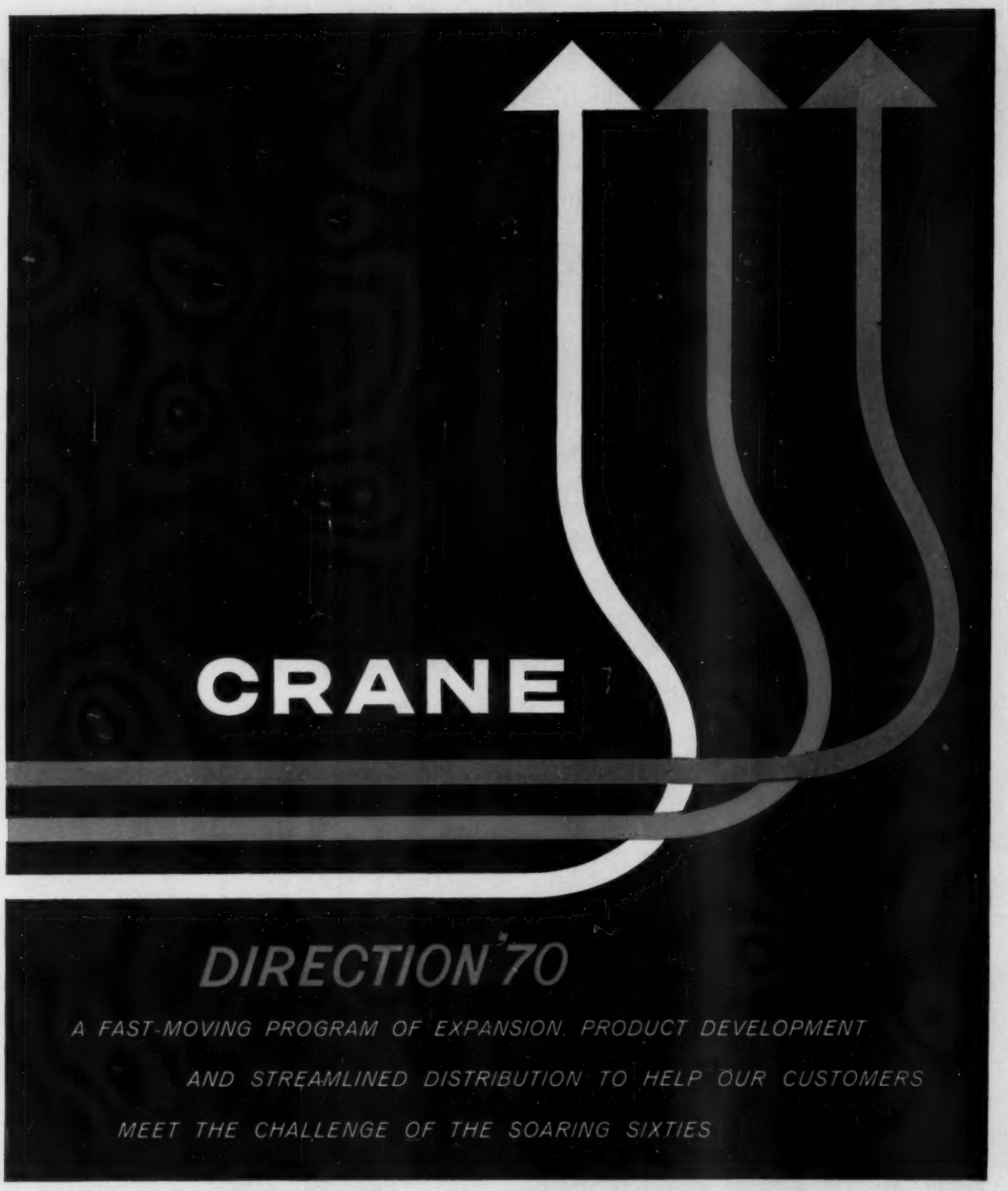
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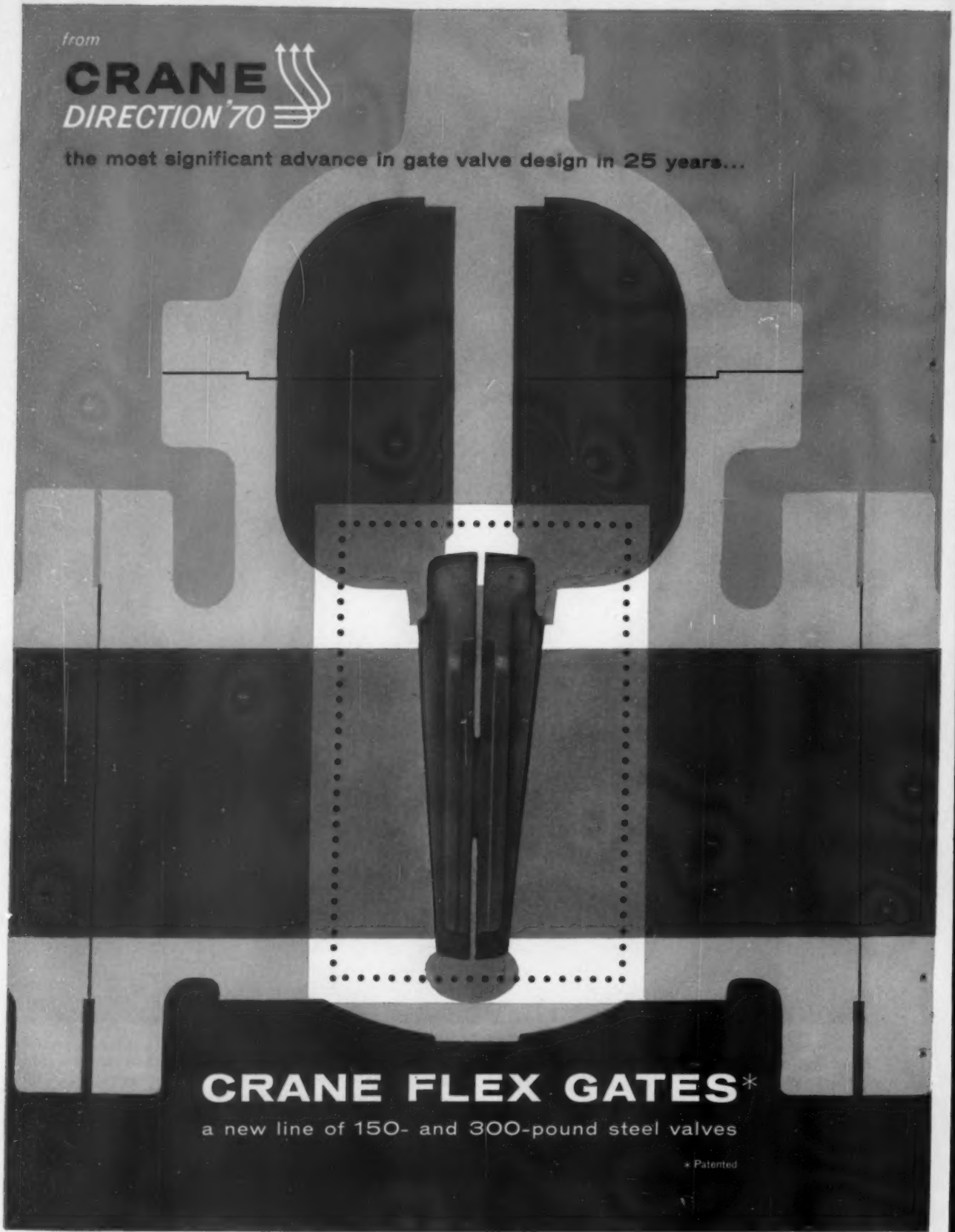
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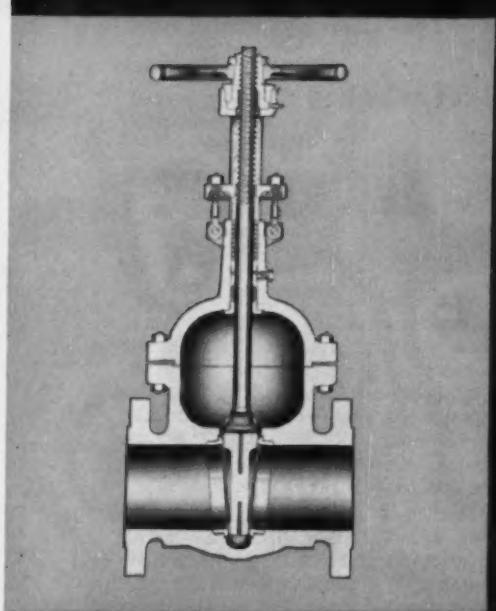

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ATOMICS

A section of POWER ENGINEERING covering current and forthcoming developments in the field of Nuclear Power throughout the world

ANDREW W. KRAMER
Editor

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A report on the work being done by Allis-Chalmers in the development and construction of the first integral nuclear superheat reactor for Pathfinder Station of Northern States Power Co.

KIWI-A PRIME

KIWI-A IS THE NAME of the nuclear reactor which has been under development and test by a joint AEC-Air Force group to investigate the feasibility of nuclear rocket propulsion. It is one of the many research and development activities being carried out under a program known collectively as Project Rover.

From a nuclear standpoint, Kiwi-A is perhaps as simple a reactor as is to be found anywhere. It consists essentially of a core made up of nuclear fuel and moderating material with vertical coolant channels. Hydrogen gas derived from a tank of liquid hydrogen passes through these channels and is heated to a high temperature. The resulting expansion of the gas creates the high pressure and consequent thrust which, it is hoped, will serve as the propelling force for the rocket.

The first of the planned series of experiments in Project Rover, using Kiwi-A, was completed last summer (1959). In a humorous vein, this reactor was named Kiwi-A after the flightless Australian bird. Since the reactor weighed more than the thrust it could produce, the name was appropriate, although neither thrust nor weight were quantities of interest for its design. The test was conducted in an area known as Jackass Flats, not many miles from the better known Frenchmen Flat, of the AEC Nevada Test Site at Mercury, Nevada.

Kiwi-A was tested in the nozzle-up position. This test configuration provided both a simple and economical installation. The primary object was to operate the reactor at high power at a predetermined temperature level and duration representative of an operational cycle. A critical experiment and a test run at low power with all subsystems operating was made prior to the high-power test. The latter test was successful on the first attempt—a significant achievement in any type of power plant initial operation. During operation the radiation levels close to the reactor were, of course, extremely high. In addition, fission products from recoil and diffusion were carried out the nozzle to the atmosphere. Radiation measurements were an important part of the test operation, and an elaborate array of instruments for such measurements was provided. Maximum fall-out of fission products occurred less than a mile from the reactor. The radiation level was such that a man standing exposed at this location during the test would have received no more than a one-week occupational dose from all fall-out effects.

The successful test of Kiwi-A last summer is now to be followed by a new series of tests this summer. These will be called the Kiwi-A Prime series of tests, and will involve two reactors, designated Kiwi-A Prime and Kiwi-A3. Both of these reactors are similar to Kiwi-A. The outcome of these new tests will be awaited with much interest, since nuclear rocket engines based on relatively simple and well-understood reactor concepts can greatly contribute to our over-all space posture within the next 10 or 15 years.

Andrew W. Kramer

First Prefabricated Nuclear Power

PM-2A is the first skid-mounted nuclear power plant to be built for remote area installation. The components are mounted on a total of ten H-beam skids and are designed so they can be flown to remote areas by standard military cargo planes. PM-2A will deliver 1560 electrical kilowatts plus about one million Btu per hr to be used for space heating

ON MARCH 29, top-level officers of the Armed Forces and other government officials gathered at the ALCO Products, Inc, plant at Dunkirk, N. Y., to witness tests of the Free World's first prefabricated nuclear power plant. This skid-mounted nuclear power plant, built for the Army Engineers under a $3.2 million contract, will be installed in snow tunnels to heat and supply electric power at Camp Century, Greenland. PM-2A, as this reactor plant is known, will deliver about 1560 net kw of electricity plus 1,000,000 Btu of steam for heating. It will be installed later this year in snow tunnels at Camp Century, an operating base of the Army's Polar Research and Development Center. Plans to install and operate the power reactor in Greenland were announced March 22 by the governments of the United States and Denmark.

The economics of this small nuclear plant are quite simple. The Armed Forces estimate that at some Arctic installations, from 70 to 80 per cent of the supply effort involves the transportation of fossil fuels for power generation. At remote sites supported by airlift, where supplies are dropped by parachute, the delivered cost of diesel fuel can exceed $2.50 per gallon.

The estimated annual diesel-oil requirement for a conventional power and heating plant comparable in output to the PM-2A, assuming operation at the same load factor, would be more than 850,000 gal, or in excess of 15,000 drums of 55 gal each. Assuming the above figure of $2.50 per gal, the annual fuel supply for the conventional plant would cost $2,125,000. With such conventional fuel costs, it is not difficult to prove that nuclear power is competitive with conventional power, even with high capital costs.

PM-2A incorporates a condenser-cooling system using air and ethylene glycol, due to the severe low temperatures encountered at the operating site. The plant breaks down for shipment into 27 air-transportable packages, with all units designed and built to meet size and weight limitations required for shipment in a

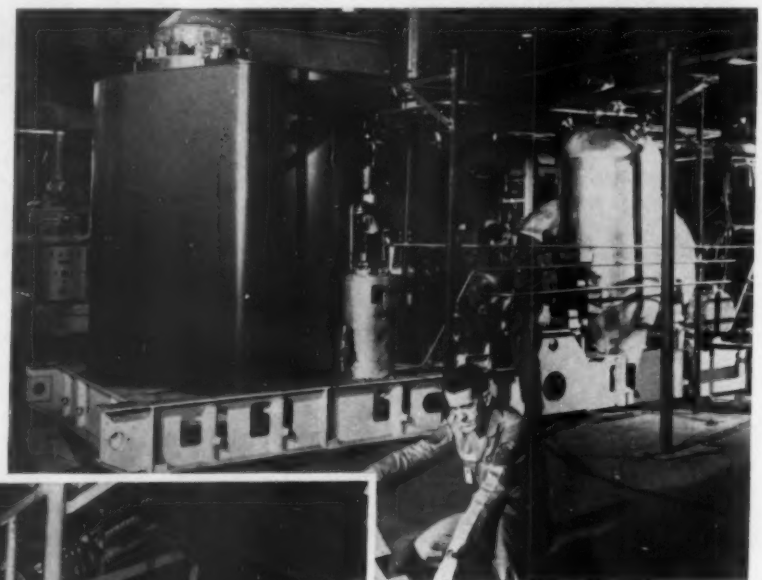

Fig. 1 (above). This photograph shows the primary system skid for PM-2A. This shows the pressurized-water reactor at the right and the steam generator at the left. This nuclear plant will be installed in snow tunnels to heat and power Camp Century, Greenland

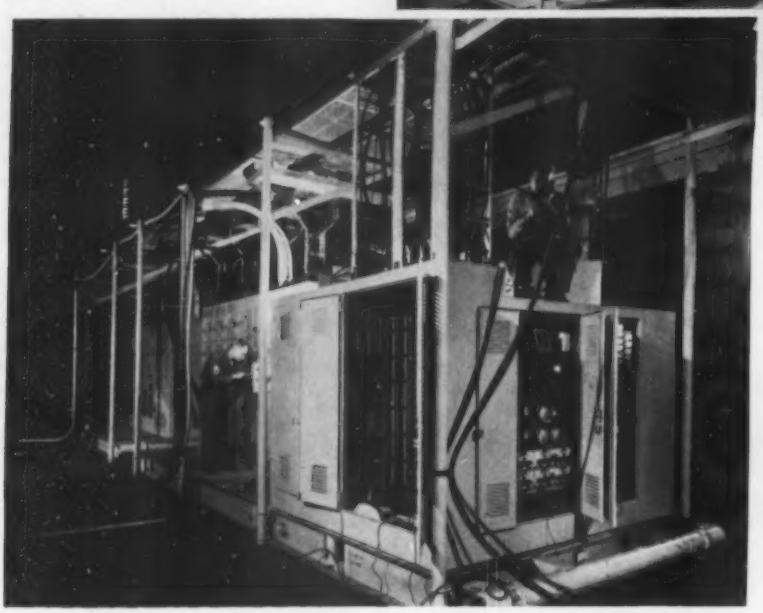

Fig. 2 (left). Here is shown the control skid fabricated by Westinghouse Electric Corp. On this skid is installed all the switchgear and control equipment, completely wired and ready to be connected to the other components when it arrives at the site

Plant Tested at Dunkirk, N. Y.

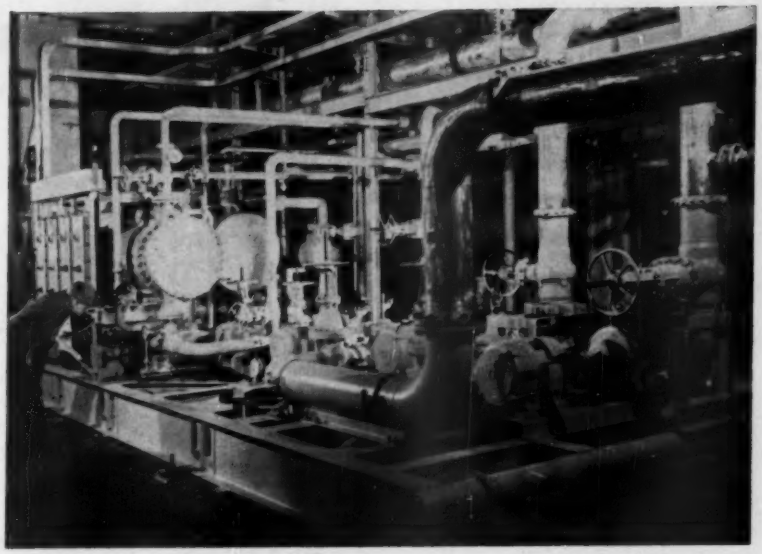

Fig. 3. This heat exchanger skid reheats water from the condenser prior to reentry of the water into the plant's steam generator. The reactor system features an air and ethylene-glycol condenser cooling system made necessary by the frigid temperatures at Camp Century

military cargo aircraft. Installation of the plant in Greenland will take six weeks, utilizing a trained crew of about 31 Army personnel, supervised by ALCO engineers. After assembly the plant will be operated initially by a 17-man force trained for this purpose at the prototype SM-1 (the formerly-designated APPR) at Fort Belvoir, Virginia. Camp Century will be manned by about 100 engineers and scientists who will conduct research studies on the ice cap.

PM-2A follows two other pressurized-water nuclear power systems in the military atomic power program. The prototype SM-1 was designed and built by ALCO in 1957 for the Army and AEC. A second stationary-type reactor, SM-1A, is now under construction at Fort Greely, Alaska, by Peter Kiewit Son's Company, from a design done by ALCO. That plant will produce twice the thermal heat rate of that developed at SM-1, from a core of the same size.

PM-2A incorporates two major advances over the SM-1 and SM-1A: Total plant weight to be transported has been reduced from 2500 tons to 300 tons, and test and assembly time has been cut from 18 months to three months. In contrast to the 850,000 gal of diesel oil which would be required by a comparable conventional plant, PM-2A will operate for 12 months on a single loading of nuclear fuel, which will be shipped to Greenland in 11 steel drums with an equivalent 55-gal capacity.

The PM-2A plant comprises 10 skids that hold all station generating equipment from the reactor vessel to the turbine generator, switchgear, and the control console. Maximum weight of a single skid is 15 tons, and the largest skid is 28 ft long, 9 ft high, and 8 ft 7 in. wide. Of the 10 skid assemblies making up the plant, ALCO fabricated six. These included the reactor vessel-steam generator skid, the feedwater heater skid, the heat exchanger skid, and three air-blast cooler skids. The turbine-generator, switchgear, and motor control skids were supplied by Westinghouse Electric Corp, and the condenser skid was built by the Worthington Corp. Advanced nuclear instrumentation was supplied by Stromberg-Carlson Division of General Dynamics, and the conventional instrumentation in the secondary side of the plant was built by the Foxboro Co.

In developing the skid-mounted plant, ALCO engineers had the benefit of extensive research, critical and zero-power experiments, and actual full-power operation in connection with the Fort Belvoir reactor. Using design criteria and studies involving SM-1, but omitting areas of the prototype design that would not lend themselves to practical portability, designers took a step-by-step approach to the prefabricated concept.

Fuel elements similar to those in the core of the SM-1 were selected for the skid-mounted design. The SM-1 fuel elements have not only been most successful in operation, but their selection made available a wealth of analytical data assuring that core configuration, size, and performance could be established with maximum reliability. Further studies into the core configuration showed that, for the skid-mounted design, SM-1 core size could be reduced by removing eight corner elements without reducing the 10-Mw thermal output of the core. Also taken directly from the SM-1 design were the control-rod drive mechanisms.

This resulted in an important, cost-saving advantage: by adapting these basic components from SM-1,

Fig. 4 (left). A snow tunnel under construction during 1959 at Camp Century. Interconnected tunnels similar to this one will hold PM-2A when it arrives in Greenland later this year

Operating Data on the PM-2A Skid-mounted Nuclear Power Plant

PLANT PERFORMANCE		
Thermal power developed in reactor		10 Mw
Reactor Core Life (Min)		8 Mw-yr
Gross electrical power generated (0.8 pf)		1980 kw
Power required for auxiliaries		420 kw
Net electrical power—with supply for heating system		1560 kw
Steam supplied for outside heating		1,000,000 Btu/hr
THERMAL DATA—REACTOR AT FULL POWER		
Operating press.		1750 psia
Design press.		2000 psia
Coolant flow		4200 gpm
Coolant inlet temp		500 F
Coolant outlet temp		518 F
CORE		
Configuration		7 x 7 array—3 elements in each corner omitted
Equivalent diameter		20.2 in.
Active core height		21.75 in.
Material content	U^{235}	19.5 kg
	B^{10}	17.0 gm
	55	172.0 kg
	H_2O (68F)	91.5 kg
STATIONARY FUEL ELEMENTS		
Type		Plate type containing enriched UO_2 dispersed in stainless steel matrix clad with stainless steel
Number of elements		32
Plates per element		18
Active length		21.75 in.
CONTROL ROD FUEL ELEMENTS		
Type		Plate type containing enriched UO_2 dispersed in stainless steel matrix clad with stainless steel
Number of elements		5
Plates/element		16
Active length		21.13 in.
STEAM GENERATOR		
	Tube side	
Operating press.		1750 psia
Design press.		2000 psia
Flow		4200 gpm
Inlet temp		518 F
Outlet temp		500 F
	Shell side	
Operating press.		465 psig
Outlet temp		463 F
Inlet temp		306 F
Flow		37,700 lb/hr
Blowdown		400 lb/hr
PRESSURIZER		
Operating press.		1750 psia
Design press.		2000 psia
Design temp		650 F
Number of heaters		20
Total heat output		20 kw
Steam volume		13.8 cu ft
Water volume		5.1 cu ft
TURBINE GENERATOR		
Throttle steam press.		450 psig
Throttle steam temp		459 F
Turbine speed		7323 rpm
Generator	3 Phase, 60 Cycle	4160 v
Condenser vacuum		8 in. hg
Condenser surface		2500 ft^2
Condensate flow		29,750 lb/hr
AIR-BLAST COOLER		
Circulating fluid		2000 gpm Glycol
Blower capacity		58,000 cfm
Air-blast cooler surface area		
Tube surface		8925 ft^2
Extended surface (fins)		116,300 ft^2
PHYSICAL DATA		
Maximum size of largest package		30 x 9 ft high
Maximum weight of heaviest package		30,000 lb
Total weight of all packages		288 tons
Number of packages		27
CONTRACT DATE		January 23, 1959
SHIPMENT DATE		May 20, 1960
COMPLETE CONSTRUCTION		September 1, 1960

the need for critical experiments, fuel plate fabrication development, and control-rod drive testing was eliminated. This helped reduce considerably the time and cost necessary to fabricate the packaged skid-mounted plant. The equivalent core cylinder diameter in the skid-mounted design is 20.16 in. by 22 in. high. The total reduction in reactor vessel diameter was 10¼ in.

Heat Removal Analysis

After fixing the geometry of the core, engineers undertook an analysis of core heat removal. The design criteria was that there be no boiling in the core at steady-state full power operation. A range of coolant flow rates and coolant inlet temperatures were studied to determine the primary system pressures required to meet the design criteria. An ALCO-developed code for the IBM-650 computer, which determines maximum fuel element plate-surface temperature, was used. The final selection of a primary system pressure of 1750 psia, and a secondary pressure of 465 psig at full load, provides a plant with good operating efficiency, low weight, and conservative operating pressures.

All primary and secondary-system "packages" in the new design have skid bases fabricated from two H-beams joined by crossties and a top deck. Draw bars are mounted between the extremities of the H-beams on each end. All electrical and instrument wiring is incorporated in the skids in conduits, with outlet boxes and quick-disconnect electrical connectors located above the deck. Mounting pads are provided for the top decks to accommodate the various components, and the mountings provide for thermal expansion where necessary. The rigid construction of the skid bases eliminates the necessity for extensive foundations at any given installation site.

The reactor is a pressurized-water reactor with a thermal output of 10 Mw. The gross electrical output of the plant (0.8 pf) is 1980 kw. The power required for driving the auxiliaries is 420 kw, leaving a net electrical output of 1560 kw. Steam supplied for outside heating is 1,000,000 Btu per hr.

The primary system pressure is maintained by an electrically-heated pressurizer having a steam volume of 13.8 cu ft. This steam space acts as a cushion at times of sudden pressure fluctuations due to changes in load.

The turbine generator operates at a throttle steam pressure of 450 psig and a steam temperature of 459 F. Additional operating data on the PM-2A plant is given in the accompanying tabulation.

ALCO Products, Inc, supplied the reactor vessel/steam generator, feedwater heater, and heat exchanger as well as the vapor container and prefabricated piping. Westinghouse Electric Corp supplied the turbine-generator, switchgear and motor control. The condenser was furnished by Worthington Corp and the primary pump by Byron Jackson Pumps, Inc. Nuclear fuel elements and rods were furnished by Sylvania-Corning Nuclear Corp, and the seal leakage pumps by Milton-Roy Co/Chemical Pump and Equipment Co. Nuclear instrumentation is by Stromberg Carlson Div-General Motors Corp, and conventional instrumentation by Foxboro, Inc. Water treatment equipment was supplied by General-Ionics Corp and Illinois Water Treatment Co. THE END

NIMROD—Britain's New 7 Gev Synchrotron

By T. G. PICKAVANCE

Director of the Rutherford High Energy Laboratory
National Institute for Research in Nuclear Science

NIMROD, a 7 Gev proton-synchrotron, will be the principal equipment in the Rutherford High Energy Laboratory now under construction on a site near the United Kingdom Atomic Energy Research Authority's Establishment at Harwell. The Laboratory is intended to be used coöperatively by university research workers and by the staff of the National Institute for Research in Nuclear Science. The field of work is fundamental research in the physics of elementary particles and in nuclear physics. Construction of the buildings and the accelerator has been undertaken by the United Kingdom Atomic Energy Authority on behalf of the National Institute.

Nimrod is a constant gradient proton-synchrotron, designed for a particle energy of 7×10^9 electron volts (7 Gev)*. Protons are accelerated (to 15 Mev) in a subsidiary machine, and injected into a vacuum vessel between the poles of a ring-shaped magnet where they travel in closed orbits. On each orbit a relatively small accelerating electric field is applied from a radiofrequency generator, and the magnetic field is steadily increased as acceleration proceeds in order to confine the protons within the magnet ring. When acceleration is complete, the magnetic field is reduced to zero in readiness for the next pulse. The time of acceleration to 7 Gev is 0.7 sec.

At any desired energy, up to the maximum obtainable, the protons are made to bombard a target in the ring, and the particles produced in the collisions are separated into their various kinds, and into different energy groups, with the help of external electric and magnetic fields. Alternatively, a large fraction of the circulating proton beam may be extracted by magnetic deflection. The resulting external beams of particles are focused and collimated, and pass through channels in a concrete shielding wall into the experimental area for use in the experiments. The whole machine is enclosed in heavy shielding, to protect the public and the workers in the laboratory from the intense radiation produced.

The injector is a 15 Mev proton linear accelerator. Protons are produced in a radiofrequency plasma in hydrogen at a pressure of a few microns Hg and are accelerated to 600 Kev by an electrostatic generator. The focused 600 Kev beam passes along the axis of a cylindrical copper resonator, 45 ft long and 7 ft in diameter, and contained in a steel vacuum envelope. Some 50 accelerating electrodes are mounted on the axis of the resonator, which is powered at 115 Mc per sec by a radiofrequency generator producing 1 Mw peak in 2 milli-second pulses. The accelerating electrodes contain magnetic quadrupole lenses which focus the beam. It is hoped that 10 microamperes of protons (during the pulse) will be injected into the magnet ring, through electrostatic and magnetic steering devices.

The magnet room of Nimrod, the 7 Gev proton-synchrotron for Britain's National Institute of Research in Nuclear Science

The magnet ring is divided into octants, separated by straight sections for injection, acceleration, and extraction of the beam. The yoke weighs about 7000 tons and contains 336 blocks built up from quarter-inch-thick insulated steel plates, bolted and welded together. It is of C-section, with no iron outside the orbit for easy beam extraction, and has a mean radius of about 75 ft.

Separate laminated pole-pieces have been designed to eliminate the effects of yoke saturation on the field gradient (which has to be held within fine limits for orbit stability). The windings are of hollow copper bar, cooled by high-pressure water circulation. The useful air gap is 36 in. radially by 9½ in. vertically, at injection, and the field at 7 Gev is 14,000 gauss.

The steel has been very carefully controlled and "randomized" at all stages of manufacture to avoid undesirable accumulation of errors in magnetic quality. The magnet yoke is being made by Joseph Sankey and Sons, Ltd, from steel plate supplied by the Steel Company of Wales, Ltd; the coils by Metropolitan Vickers Electrical Co Ltd; and the pole pieces by the English Electric Co Ltd.

Magnet Power Supply

Two three-phase alternators, of about 100 Mva combined rating, are driven on a common shaft by two motors of 6000 horsepower together with two 50-ton flywheels for energy storage during pulses. These are connected through phase-splitting transformers to 96 excitron rectifiers and thence to the magnet windings. After acceleration the excitrons are switched electronically to inversion, whereupon most of the stored energy in the magnet (40 megajoules) is returned to the rotating machinery.

The rotating machines are being manufactured by the English Electric Co Ltd, and the rectifier equipment by the Brown Boveri Co at Baden, Switzerland.

Two ferrite-tuned cavities, in one of the straight sections, provide 7

*7 Gev is equivalent to 7 Bev in U. S. terminology

Kev acceleration per circulation. The frequency is varied from 1.4 to 8 Mc per sec (four times the proton orbital frequency) on an accurately controlled law. Signals from the magnet are converted into frequency variation in a computer coupled to an oscillator which feeds the cavities through several board-band amplifier stages. Control by the motion of the protons will be used later.

The double-walled vacuum system vessel is being made from epoxy resin and glass cloth by Marston Excelsior Ltd. The outer wall contains and is supported by the magnet pole pieces, and is evacuated to about 1 mm Hg, and the inner chamber, between the poles, to 10^{-6} mm Hg. The 40 high vacuum pumping units are being supplied by Edwards High Vacuum Ltd.

The magnet hall, 200 ft in diameter, is a concrete structure supporting 20 ft of earth shielding overhead and much more around the sides. A 30-ft-thick concrete wall, 160 ft long, separates the machine from the main experimental hall and permits a wide range of beam channels to be installed. Auxiliary buildings house the power supplies, control equipment, experimental preparation area, workshops, and laboratories. The civil engineering construction contract was awarded to W. E. Chivers and Son, Ltd, and Messrs. Merz and McLellan are the consultants.

Site work was started in July, 1957, and many of the buildings are now completed. More than two-thirds of the magnet yoke blocks had been delivered by early 1960, and components of the injector were being delivered. Completion is expected early in 1962, when commissioning of the accelerator will begin. Physicists and engineers of the Harwell Project team have produced the designs and specifications, aided by many industrial firms of whom only those with the largest contracts have been mentioned.

The design performance is as follows:

Energy.....variable, 7–8 Gev maximum
Pulse repetition rate:.....variable, 28 pulses per minute maximum at 7 Gev
60 pulses per minute maximum at 3 Gev
Internal proton beam intensity....10^{12} protons per pulse
Number of external proton beams....2, about 2×10^{11} protons per pulse maximums.

THE END

Superheated Steam From Nuclear Energy

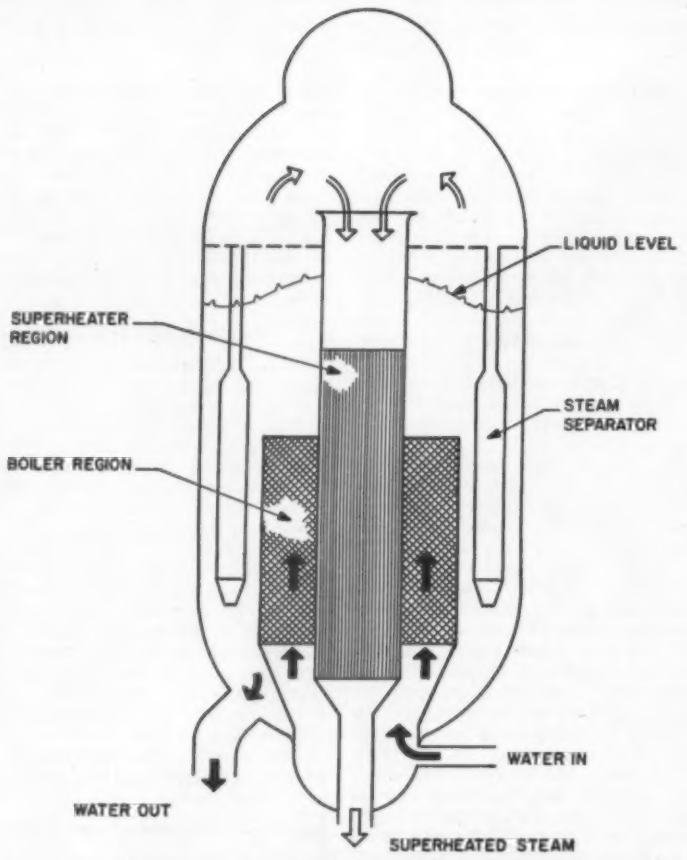

Fig. 1. Simplified diagram of the Pathfinder Integral Superheater Controlled Recirculation reactor

FROM THE EARLIEST beginnings of nuclear power reactor technology, it has been obvious that the steam conditions produced by the pressurized- and boiling-water reactor systems are not such as to be attractive to designers and operators of modern high efficiency power plants. Modern steam plants require high-pressure, high-temperature superheated steam, and the reactors available have been able to produce only saturated steam at relatively low pressures. In the design of some nuclear power plants, as in the case of the Indian Point Station, the steam temperature limitation of the pressurized-water system is overcome by the use of a separate oil-fired superheater which superheats the steam after it leaves the steam generators. This, however, is not a desirable solution from a nuclear standpoint, and it is generally agreed that future nuclear power development should lead to the development of a nuclear reactor incorporating an integral nuclear superheater.

During the last few years this aspect of nuclear plant development has received a great deal of study, and a number of experimental projects have been under way at various AEC and private laboratories. This research indicates that there is good reason to believe that a practical nuclear superheater can be developed, and under the AEC Power Reactor Demonstration Program, construction of three major facilities to demonstrate the feasibility and economy of nuclear superheat have been authorized: The Pathfinder Atomic Power Plant, BORAX-V, and BONUS (BOiling NUclear Superheat).

BORAX-V is the fifth of a series of boiling reactor experiments under the direction of Argonne National Laboratory. Initially it will produce superheated steam from a number of test channels, but the reactor will be converted gradually into an integral nuclear superheat reactor, and is scheduled to become critical in 1961.

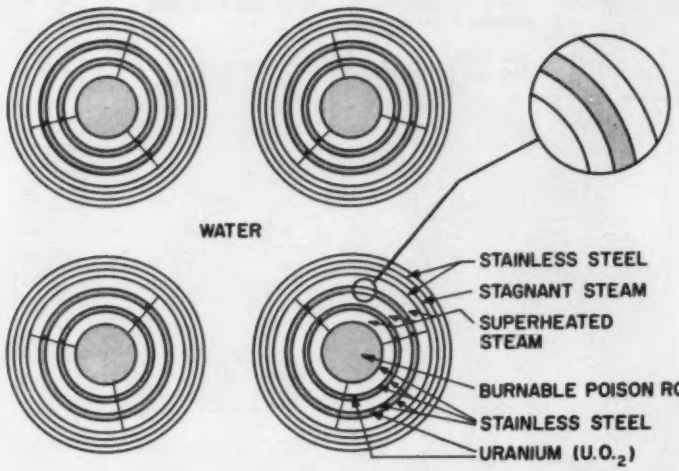

Fig. 2. Details of high enrichment superheater fuel and arrangement in reactor

The AEC has signed a contract with the Puerto Rico Water Resources Authority for construction of a 16-Mw(e) boiling nuclear superheat reactor. One of the objectives of this project is to determine the practicality of small reactors with integral nuclear superheat. The date for criticality is 1963.

Pathfinder Project

The most important project in the development of nuclear superheat is that of the Pathfinder Plant, scheduled for criticality in 1962. This is the nuclear power plant of the Northern States Power Co at Sioux Falls, N. D., being designed by Allis-Chalmers Mfg Co. Recent progress in the development of this project was described at the American Power Conference by C. R. Braun and C. B. Graham, both of Allis-Chalmers' Nuclear Power Department.

A schematic diagram of the integral nuclear superheat reactor for this project is shown in Fig. 1. The reactor, the Controlled Recirculation Boiling Reactor (CRBR) with nuclear superheater, will be of the heterogeneous type with light water serving as coolant and moderator. The coolant will be circulated by centrifugal pumps to increase stability and power output over that which could be achieved from the same core with natural coolant circulation.

The reactor will be designed for a heat power level capability of 157,200 kw in the boiling region with a circulation rate of 60,000 gpm. The steam generation rate will be approximately 618,500 lb per hr at an operating pressure of 600 psig and a temperature of 489 F in the boiling region. The integral nuclear superheater will raise the steam temperature to 825 F with a pressure drop of 60 psi or less. The total plant heat output will be 196,000 kw with the turbine-generator producing 66,000 gross kw. Net power is 60,700 kw resulting in an over-all net plant efficiency of 30.5 per cent.

As indicated in the diagram, Fig. 1, the nuclear superheater is located in the center of the boiling-water reactor. The reactor core consists of two regions: (1) the annular boiling region in which saturated steam is produced and flows to the dome of the reactor vessel, and (2) the central core region in which the steam is conducted down a multiplicity of tubes containing stainless steel clad fuel elements. Heated to 825 F, the steam then passes through the bottom of the reactor directly to the turbine. The boiling and superheater regions are designed to function together as a single reactor. The superheater section is a right cylinder 6 ft high and 30 in. in diameter.

The boiling region is located around the superheater as an annular section 21 in. in radial depth, resulting in total active core dimensions of 6 ft diameter and 6 ft high. In its plan view, the superheater consists of a large number of tubes in which steam flows over fuel elements. The space between the tubes is filled with water moderator. Double-walled tubes with a stagnant steam layer between the walls separate the superheated steam and water. The stagnant steam serves as a thermal insulator between the water and hot steam. The superheater cylinder is supported at the base by a header into which the superheated steam is discharged.

Uranium dioxide pellets will be used as fuel for the boiler region of the reactor. It is proposed that these pellets be jacketed by an aluminum alloy, but there is still some doubt as to whether the corrosion resistance of aluminum will be adequate. The fuel, in the form of rod bundles, will be assembled in 5-in. square boxes, 8 ft long, with an active fuel length of 6 ft. There will be 96 such subassemblies constituting the annular boiler region.

High enrichment fuel will be used for early loadings of the superheater. Each fuel-bearing tube is made by cladding a tube of UO_2-stainless steel cermet on both inside and outside with stainless steel. The uranium in these elements is enriched to 93 per cent with U^{235}. Two fuel-bearing tubes of different size are assembled concentrically with a hanger piece to form a fuel element. Steam flows between and around these fuel-bearing tubes. A small tube of burnable poison is located in the center of the inner tube. The arrangement of the superheater fuel elements in the reactor is shown in Fig. 2.

Although high enrichment fuel will be used in the early loadings of the Pathfinder superheater, a cost study shows that a low enrichment element — enriched to approximately 2 per cent with U^{235} — could be used to improve considerably the economics of the fuel cycle, because of the plutonium produced. The design of the superheater is such that this 7-pin low enrichment fuel element can be directly substituted for the 93 per cent element used in the reference design. The 7-pin low enrichment fuel element is shown in Fig. 3. The

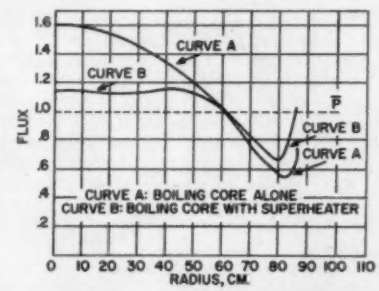

Fig. 4. Radial thermal-neutron distribution for the boiler core alone and for the boiler core with superheater

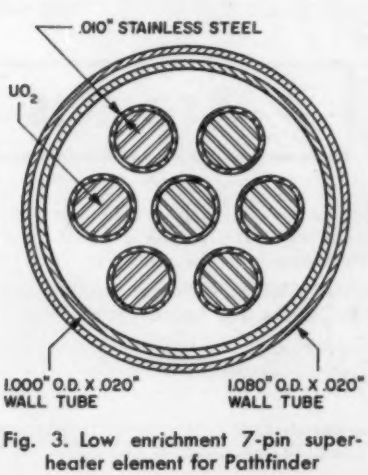

Fig. 3. Low enrichment 7-pin superheater element for Pathfinder

conceptual design of this low enrichment fuel element is very similar to the 7-pin fuel to be used in the Experimental Gas-cooled Reactor (EGCR). Both fuels (Pathfinder and EGCR) are encased in stainless-steel jackets, which are supported by the pellets under maximum temperature and pressure conditions. Irradiation of EGCR fuel to burnups of from approximately 1000 to 2000 Mwd/ton, at surface temperatures ranging from 1300 F to 1600 F, through numerous thermal cycles, has been evaluated with satisfactory results.

Pathfinder calculated hot-spot temperature is 1400 F, and expected operating maximum is approximately 1250 F. Thus, it can be concluded that the successful development of low enrichment fuel for Pathfinder is highly probable. Considerably more development work will be required, however, before this element can be used with confidence.

Power distribution throughout the core is a very important factor in determining average power density. Location of the superheater in the center of the core improves the flux distribution, as shown in Fig. 4.

The proposed design minimizes the reactivity that will be added to the reactor when the steam passages are flooded with water. Dispersal of the fuel into small units and a proper water-to-fuel ratio accomplishes this. A theoretical analysis indicates that the reactivity addition due to flooding is low enough to remove any question of safe operation. These calculations are being confirmed by tests in the Allis-Chalmers critical facility at Greendale, Wis, where a full-scale working model of the Pathfinder core including superheater is being tested.

Because both boiler and superheater regions function as a single reactor, the same control system used for the boiler region adjusts the power of the superheater region proportionately. Relative power adjustments, necessitated by different fuel burnups in the two regions, are made by means of poison rods located in the superheater region. These also adjust the final steam temperature.

Pathfinder, as the first station of its kind, is essentially a demonstration plant of relatively moderate capacity. Studies are being made, however, on the possibility of building considerably larger nuclear superheater reactors and extrapolation to 330 Mw(e) from the 66-Mw(e) Pathfinder plant appear to be reasonable.

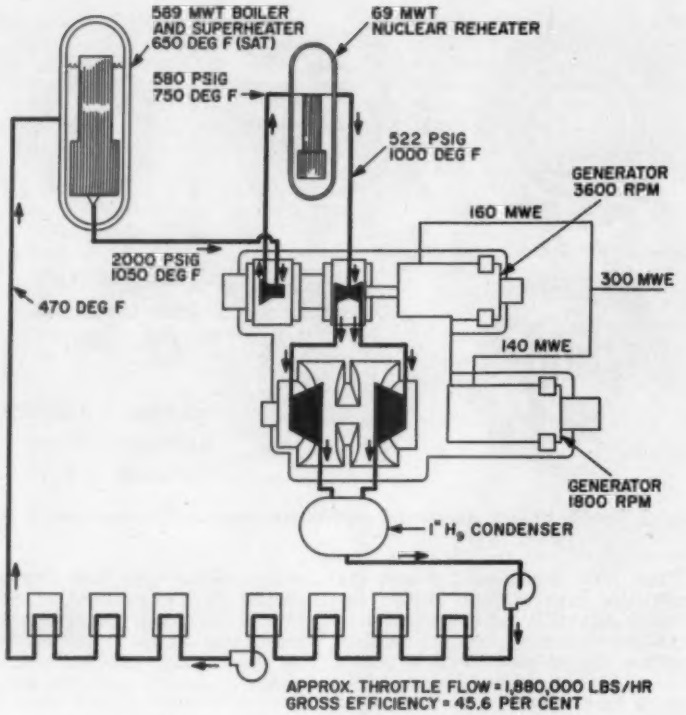
589 MWT BOILER AND SUPERHEATER 650 DEG F (SAT)
69 MWT NUCLEAR REHEATER
580 PSIG 750 DEG F
522 PSIG 1000 DEG F
GENERATOR 3600 RPM
160 MWE
2000 PSIG 1050 DEG F
300 MWE
470 DEG F
140 MWE
GENERATOR 1800 RPM
1" H_g CONDENSER
APPROX. THROTTLE FLOW = 1,880,000 LBS/HR
GROSS EFFICIENCY = 45.6 PER CENT

Fig. 5. A target 330-Mw(e) nuclear power plant using natural circulation, an integral superheater, and a separate nuclear reheater

The reactor vessel diameter, power density, boiler heat flux, and superheater hot-spot temperatures for such a 330-Mw(e) plant are approximately the same as for the 66-Mw(e) Pathfinder plant. The development of a moderately high strength steel was assumed, resulting in a vessel wall thickness of 8 in.

An interesting feature of the conceptual design of the 330-Mw(e) plant is the use of a separate nuclear reheater. This, as shown in Fig. 5, reheats the 580 psig, 750 F steam from the high-pressure turbine element, to 1000 F before it enters the intermediate pressure turbine. The steam conditions in this reheater approximate those in Pathfinder. A separate reheater reactor is used because reheat is performed at a pressure which is much lower than the main reactor pressure. Further, a third nuclear region in the main reactor is believed to be too complex and difficult to control. Nuclear reheaters could not be justified for plants much smaller than 330 Mw(e), however, because of their relatively high capital costs. Although the reheater vessel is small and inexpensive, control-rod drives, radiation shielding, and other equipment are needed. Also, the core does not conserve neutrons as well as the main reactor.

In this concept, both reactors are in a conventional building which also houses the turbine generator. They are located in a position which is most favorable for piping, shielding, refueling, and repairs. Both reactors are provided with reliable systems which prevent gross melting of the fuel jackets under all abnormal conditions. THE END

ATOMICS

REPRINTS OF ATOMICS

Reprints of the ATOMICS sections from POWER ENGINEERING for the six months from January to June 1960 will be ready about the middle of July. They will be available at $1.00 per copy. If you want one of these reprints, please fill in the following form and send it to

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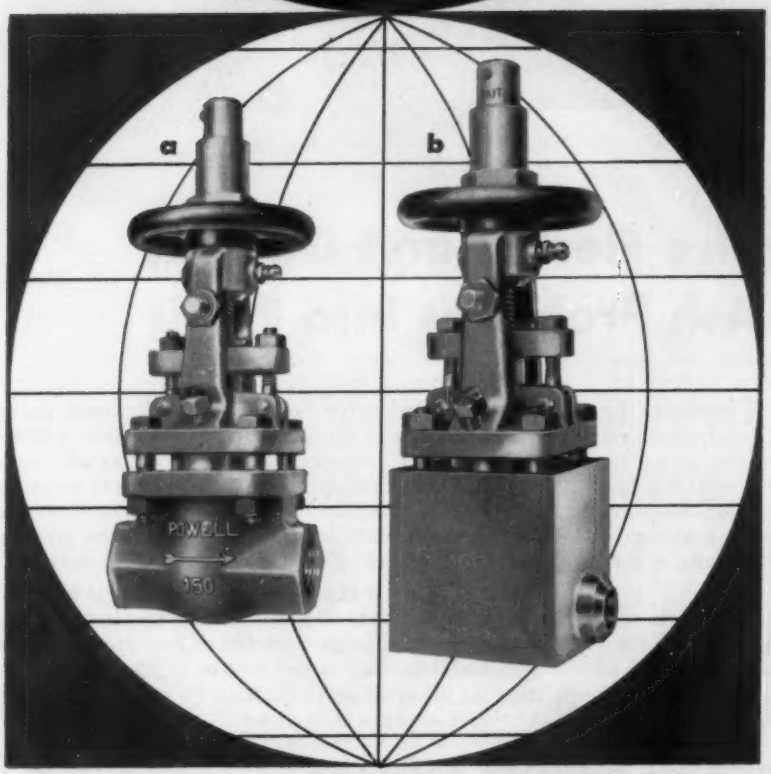

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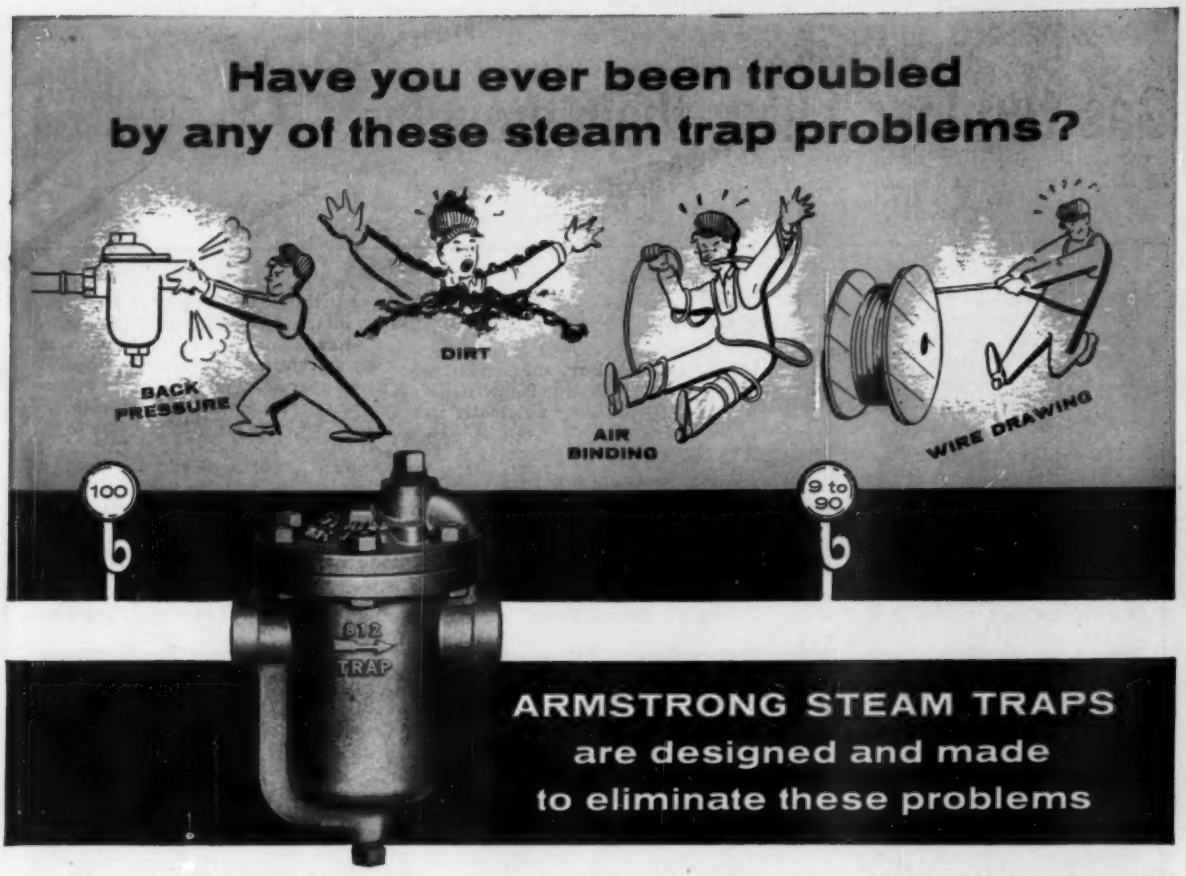

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By R. L. Steer, Project Engineer, Brown Boveri Corp.

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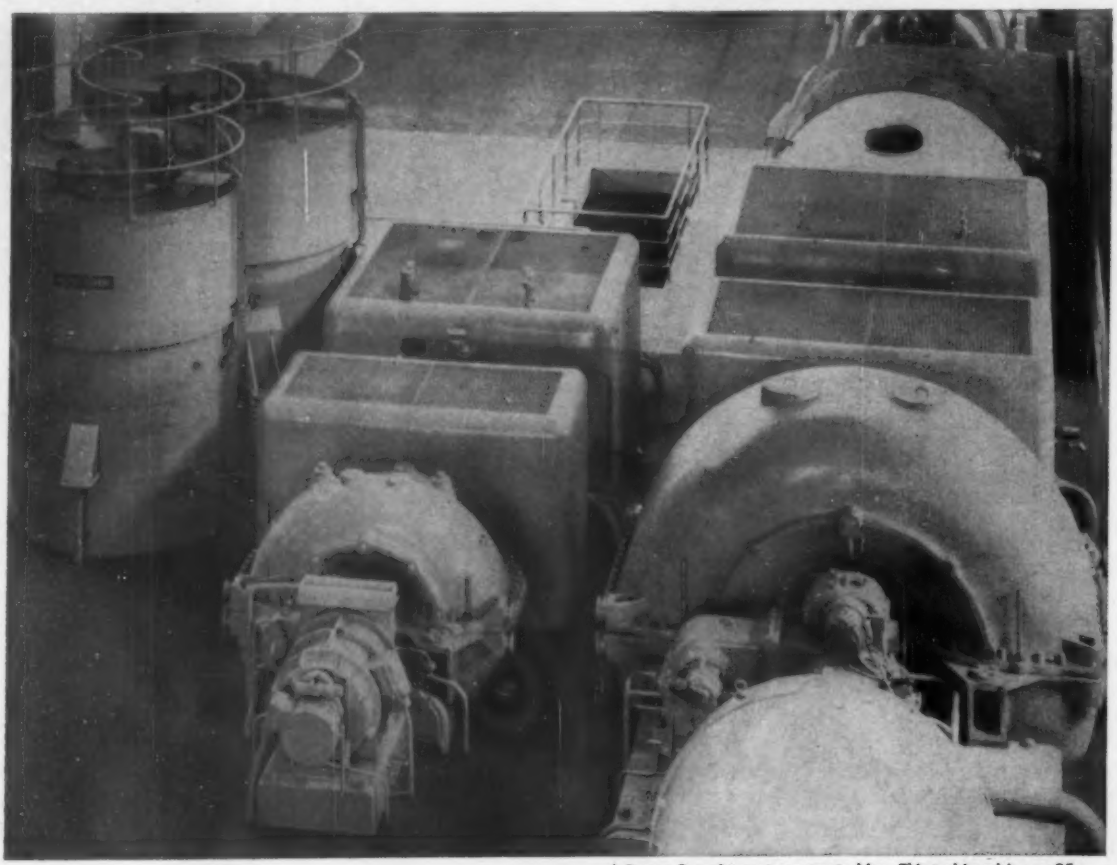

A Brown Boveri two-stage gas turbine. This turbine drives a 25 mw generator part of which is visible at the lower right corner of the photo. Starting time from cold to full load is less than 20 minutes.

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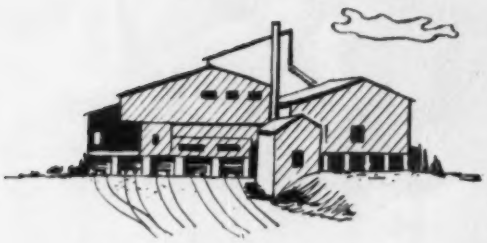

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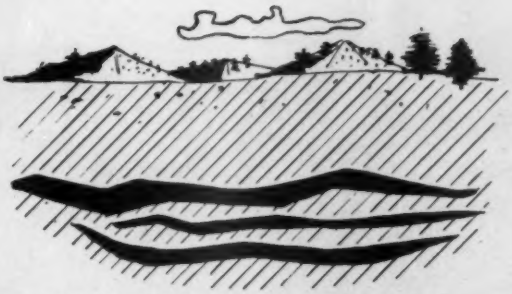

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The great reserves of unmined coal owned and leased by The Valley Camp Coal Company assure our customers a dependable source of quality coals far into the future.

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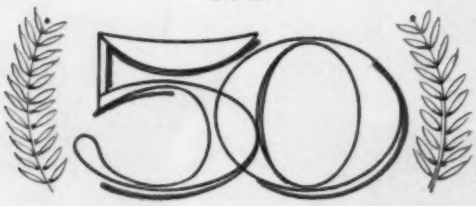
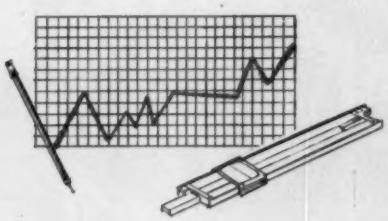


YEARS OF EXPERIENCE

We are in our third generation of working with the steam power requirements of American and Canadian industry. This accumulative experience benefits our customers through a constantly improved coal service.



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Our combustion engineering service exists for one purpose, to assist our customers in getting the lowest possible steam costs with Valley Camp Quality Coals.

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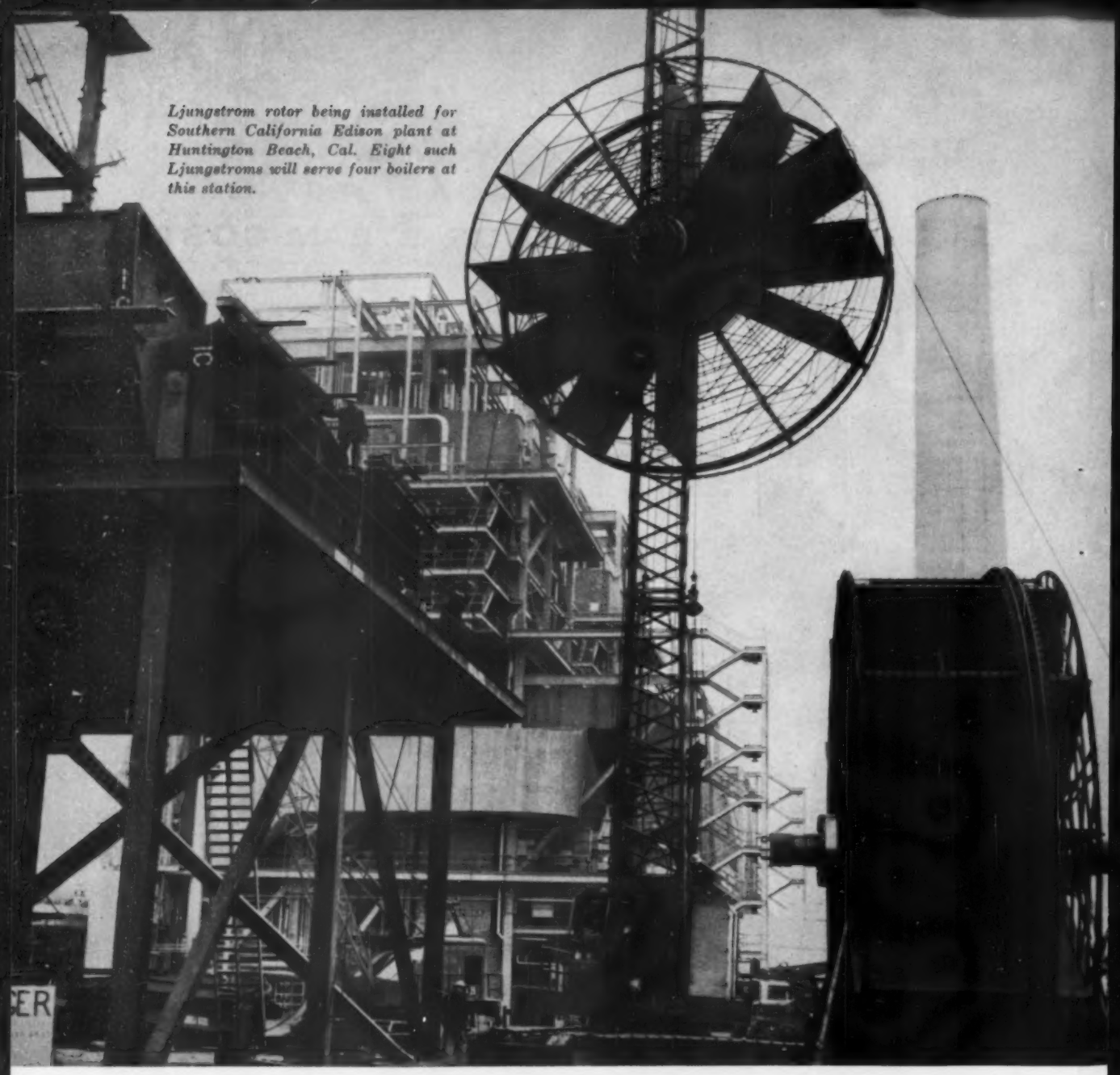

Ljungstrom rotor being installed for Southern California Edison plant at Huntington Beach, Cal. Eight such Ljungstroms will serve four boilers at this station.

AIR PREHEATER SERVICE WILL STILL BE IN EFFECT ON THESE UNITS IN THE YEAR 2000

These new Ljungstrom® Air Preheaters, being installed at Southern California Edison's Huntington Beach Station, will be protected by an unusual service policy, one that guarantees regular inspection by Air Preheater engineers throughout the life of each unit.

There's no terminal date on this service – it's in effect as long as the units are in operation. In fact, Lifetime Air Preheater Service is still helping to keep the first Ljungstrom installation in the U.S. running perfectly, although it's been in operation almost 40 years.

Air Preheater provides first-rate *factory* service too, In one instance, in response to a last-minute decision to replace cold-end elements near the end of a scheduled shutdown, Air Preheater *fabricated and shipped* over 13,000 pounds of heating elements the day after the order was received.

Regular inspection and fast factory service are just two of the advantages Air Preheater offers its customers. Another is expert knowledge of boiler and preheater problems, gained through 35 years' experience. This combination—knowledge of customer problems and a *continuing* interest in them – probably explains why nine out of ten preheaters sold today are Ljungstroms.

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

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Hall Industrial Water Report

VOLUME 8 JUNE 1960 NUMBER 3

394 Δισεκατομμύριον

The Greek word is billion. But you don't have to savvy Greek to know that 394,000,000,000 gallons is a lot of water. U. S. Industry is expected to be using this much each day in 1980.

Some of the water will be used as is. However, a sizable portion will require treatment to make it suitable for use. This might involve clarification, softening, silica removal, alkalinity adjustment, demineralization, or chemical conditioning to control corrosion or the accumulation of slime. And waste water may have to be treated for disposal or to recover valuable raw materials.

Water problems are Hall Laboratories' business. Experienced Hall engineers are ready to help you plan how to treat your water and how to tackle your water problems.

Excessive Sewer Tax

The size of his sewage bill shocked a manufacturer into the realization that he was contaminating a surface water supply. Waste water was being discharged in part to the municipal sanitary sewage system, in part to a small creek. Discharge to the creek was supposedly nothing but uncontaminated cooling water. However, the municipal authority proved that the water going to the creek was high in suspended solids and oil.

The municipal ordinance required the payment of a surtax if a plant's industrial waste waters contained suspended solids and BOD in excess of normal concentrations in sanitary sewage. Furthermore, plants discharging polluted waters to a surface supply had to pay sewer tax and surtax just as if it were going into the municipal sewers.

A lot of money was involved. Hall Laboratories was retained to determine how the contaminants got into the water going to the creek and how to stop them. After location of the sources, waste waters could be diverted to the sanitary sewage system. The preferred solution, however, was to clean up the waste waters, if this could be done economically. The latter solution would obviate payment of sewer tax and surtax on the water involved.

Hall staff engineer E. G. Paulson worked out procedures for disposing of the industrial wastes which made it possible to drop taxes from $600.00 to $75.00 monthly.

Aluminum Interference in Dyeing

Processing and dyeing of cotton fabrics had almost stopped in a Southern textile mill because of serious trouble in the dyeing operations. Practically all output was unsatisfactory because of migration of dye and deeply colored specks.

Hall industry specialist, Eric Laurin, was given a rush call. He soon established that the difficulty was due to the presence of an excessive amount of aluminum in the clarified and filtered process water.

Inspection of the filter plant showed the settling basins to be old and under capacity for the amount of water required. Floc formation with aluminum sulfate was poor and the water was carrying it out of the settling basins onto and through the filters.

By rearranging baffles in the settling basins and adjusting chemical feed, Laurin was able to improve the condition of the clarified water sufficiently to permit operation. However, floc was still carrying over to the filters and there was continuous danger of further trouble.

The next step was use of a Hagan Coagulant Aid. Results were immediate. Settling of floc in the basins was so rapid that there was practically no carryover to the filters. This was true even with 25% less aluminum sulfate. Several years have now gone by without recurrence of the costly condition.

Calcium Chloride Regeneration

When a dealkalizer in a hospital boiler plant suddenly stopped dealkalizing, Hall field engineer J. Printz received a rush call for help.

The sudden loss of effectiveness led Printz to suspect that the anion exchange material had become coated with something that was acting as a barrier between the water and the resin. Since the raw water seemed normal, his investigations took him almost immediately to the alkaline salt solution used for regeneration. He needed to go no further. One of the operators, to whom brine was brine, had dumped into the sodium chloride brine tank six hundred pounds of calcium chloride intended for preparation of brine for a refrigeration system. When the solution, with some caustic soda added, was used for regeneration of the anion exchanger, enough calcium compounds were precipitated on the exchange material to effectively insulate it from contact with water during operation.

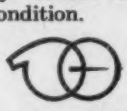
Printz reasoned that if his diagnosis was correct the normal capacity of the dealkalizer should be restored by treatment with a solution of sodium hexametaphosphate (Hagan Phosphate), utilizing the ability of this material to sequester calcium and dissolve many calcium compounds. The procedure worked successfully and the equipment was promptly back in service.

Water is your industry's most important raw material. Use it wisely.

Industrial Water Problems Require Special Handling

There are no "stock answers" to industrial water problems. For information on how the Hall System can help you solve your particular water problems, write, wire or call address below.

HALL LABORATORIES
HAGAN CENTER, PITTSBURGH 30, PA.
Consultants on Procurement, Treatment, Use and Disposal of Industrial Water



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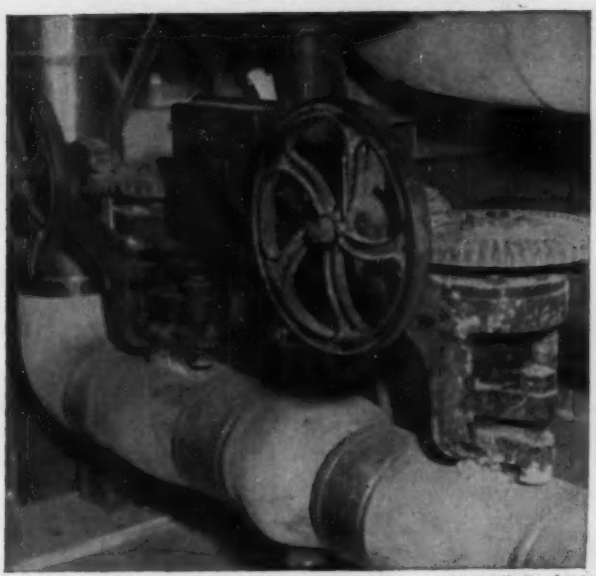


1¼" Hancock Valves in feedwater pump service (6500#-706°F.)

¼" Hancock Valves on feedwater flow meter taps (6500#-650°F.)

¼" Hancock Valves on main instrument lines (5000#-1150°F.)

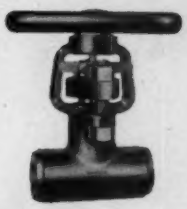
VALVE DURABILITY
MATCHES
SUPERCRITICAL PRESSURES

Rated at 5000#-1150°F., Hancock Valves were selected for the new unit of the Philo Plant of Ohio Power Co. where boiler operation is at pressures and temperatures above the critical. *Stay-in-the-line durability* explains why design engineers and steam plant operators prefer these valves for feedwater service, drips, drains, vents and other piping.

Hancock Valves are easily serviced in the line. The bonnet is permanently welded to the body. No bonnet joint to leak. No seal weld to cut—no danger of damage to internal parts. The stellite seat is integral. No seat joint to leak. Seat refinishing is quick and easy with a power drill and reseating tool. The stellite disc is replaceable. The stem resists galling, erosion, thread wear; inhibited packing prevents stem pitting. No need for destructive "cheater" loading—handwheel operation is easy, closure positive against full rated pressure.

Protect personnel, plant and service to customers with durable Hancock Valves. Ask your nearby industrial supply distributor for complete details.

Sizes: ½" thru 2". OS&Y. Service Ratings: For all pressures up to 5000 psi at 1150°F. Weld Ends.



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H4-58

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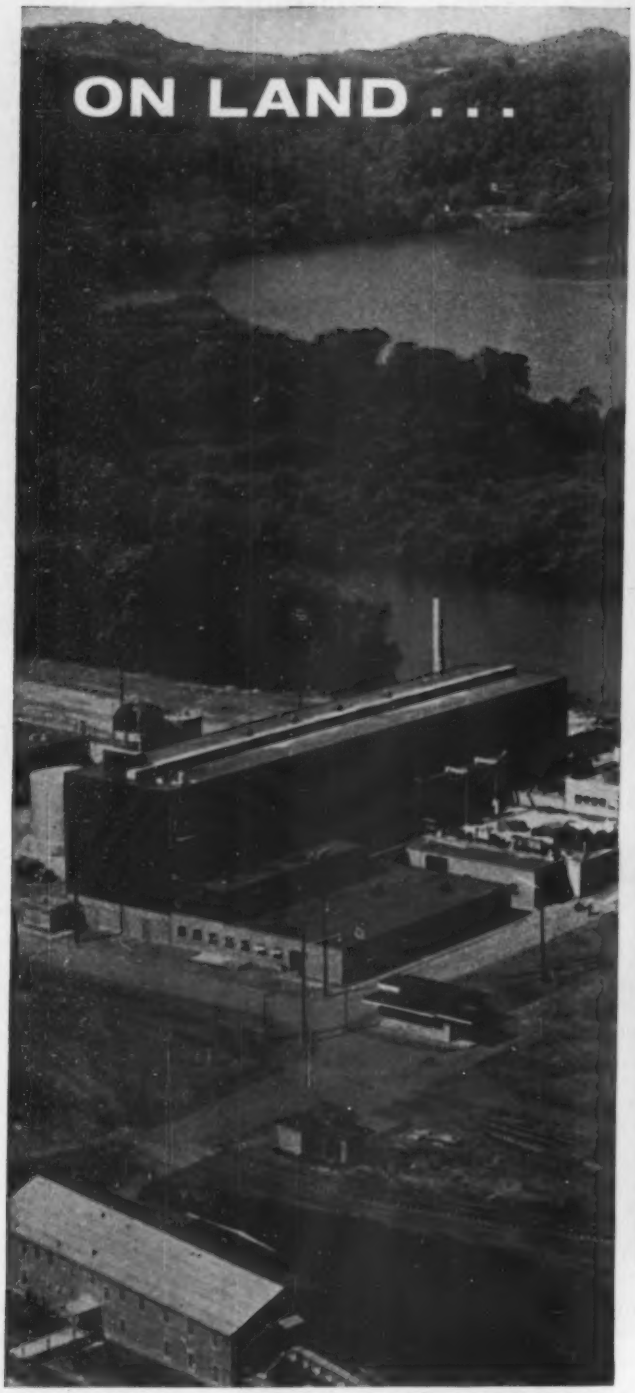
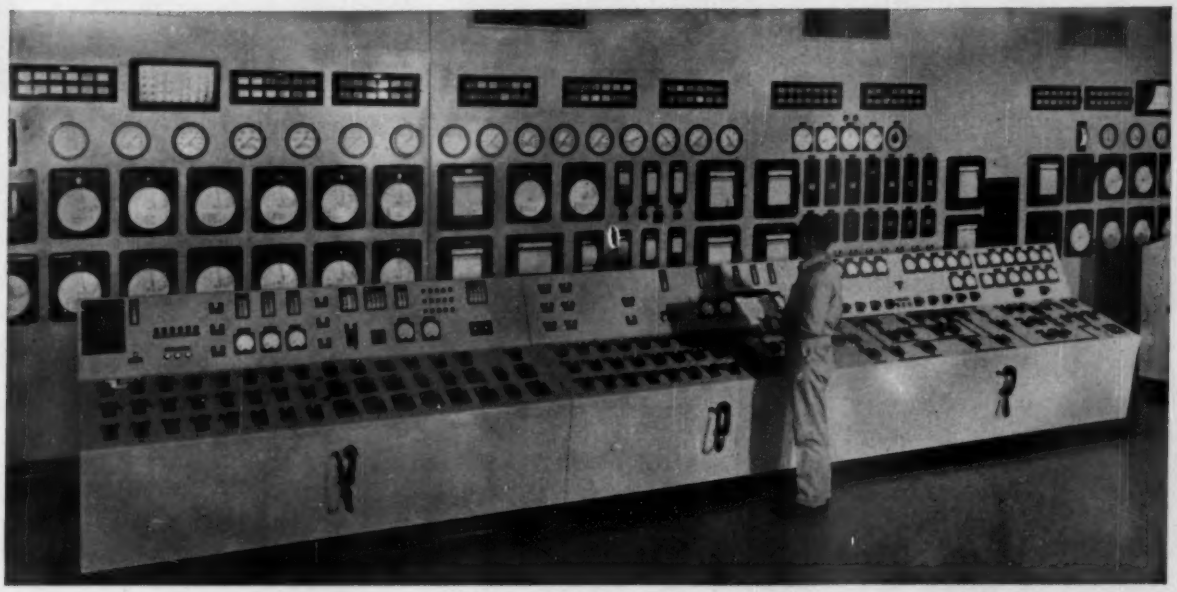


At the Shippingport Station, world's first full-scale atomic, electric power plant devoted exclusively to civilian use, Bailey instruments and controls help to secure full capacity and safety.

Typical of the modern U.S.-Flag tanker fleet using Bailey controls is the ESSO Gettysburg. You'll also find Bailey controls aboard Naval ships, cargo ships and lake steamers.

Bailey meters and controls in centralized control room at Tulsa Power Station, Public Service Company of Oklahoma. In steam-electric generating plants of this kind, Bailey has installed more combustion, feed water and steam temperature controls than have all other makers combined.

IT'S BAILEY. . .



for the latest and safest instruments and controls for nuclear and conventional power plants!

Many of the power plants of the future will have controls and instruments designed and built by Bailey. There are two reasons: Bailey's continuing research and development toward the latest equipment for industry's needs; Bailey's 40-year association with the hardware and economic requirements of the industry.

If you are planning new or improved power plant facilities, call on Bailey engineers to insure that your system will have the *proper balance both as to economics and needs . . . that there will not be the unnecessary expense of over-instrumentation or control . . . nor the duplication of equipment functions.*

Call on Bailey for primary sensing devices, indicators, loggers, control units, panels, data handling equipment, computers for performance analysis, and supervisory controls. You'll find designs ranging from conventional to the most sophisticated . . . mechanical, pneumatic, electric and electronic, including solid state.

There's a Bailey District Office or Resident Engineer close to you. Check your phone book, or write direct.

A142-2

Instruments and controls for power and process

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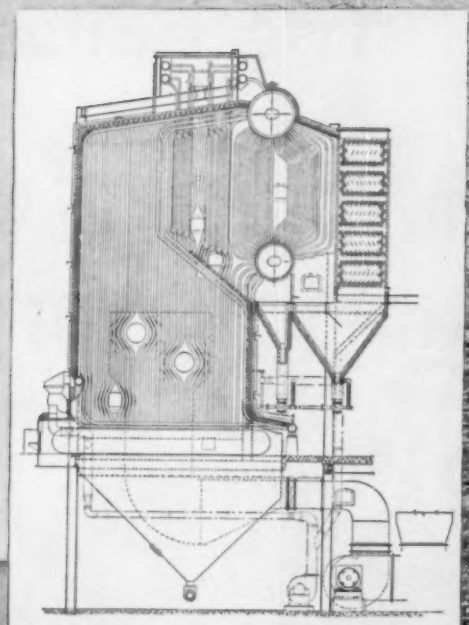
FUEL SAVINGS 16%



Longitudinal section of Union Type VO Steam Generator at City of Ames.

JOB: Includes delivering steam for a 12,650 KW Turbo-generator in Municipal Power Plant, City of Ames, Iowa.

STEAM GENERATOR: A Union Type VO Single-Pass (140,000 lbs./hr., 630 psi, 825° F). Fired by continuous ash discharge spreader stoker. Equipped with extended surface economizer for heat recovery. Selected for its adaptability to multi-fuel firing.

RESULTS: In continuous operation for six months, supplying total steam requirements, the Union VO was credited with fuel savings of 16%.

MORE INFORMATION: Many types and sizes of Union Steam Generators are described in illustrated Bulletin GB-959. Write: Union Iron Works, Erie, Pennsylvania.

UNION

steam generators

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GET LOW-COST DEPENDABLE PROTECTION FOR LOW PRESSURE BOILERS WITH AN H20® CHEMICAL METERING PUMP

Benefits include lowest cost ever, a new record for low maintenance requirements, and easier servicing. The H20 controlled volume pump not only costs less to purchase and install, but it costs less to operate at the peak of efficiency than any other comparable chemical feeder. The H20 metering pump is based on the same principles that have made Milton Roy controlled volume pumps famous. But in the interests of economy, every working part has been simplified and redesigned for production line manufacturing. There's been little sacrifice in accuracy, and none at all in dependability.

Around the clock, you can depend on your H20 pump to meter the necessary mild, non-corrosive treatment chemicals to your boiler feed, cooling tower, and process make-up water. The H20 is available immediately from stock. Even completely piped and assembled chemical feed systems with simplex or duplex H20 pump and 50 or 100 gallon steel tank can be shipped within 24 hours. They're ready to go to work immediately, accurately and economically metering chemicals against pressures to 600 psi.

GET COMPLETE FACTS *on the H20 pump and packaged chemical feed systems in Bulletin 558. Write Milton Roy Company, 1300 East Mermaid Lane, Philadelphia 18, Pennsylvania.*

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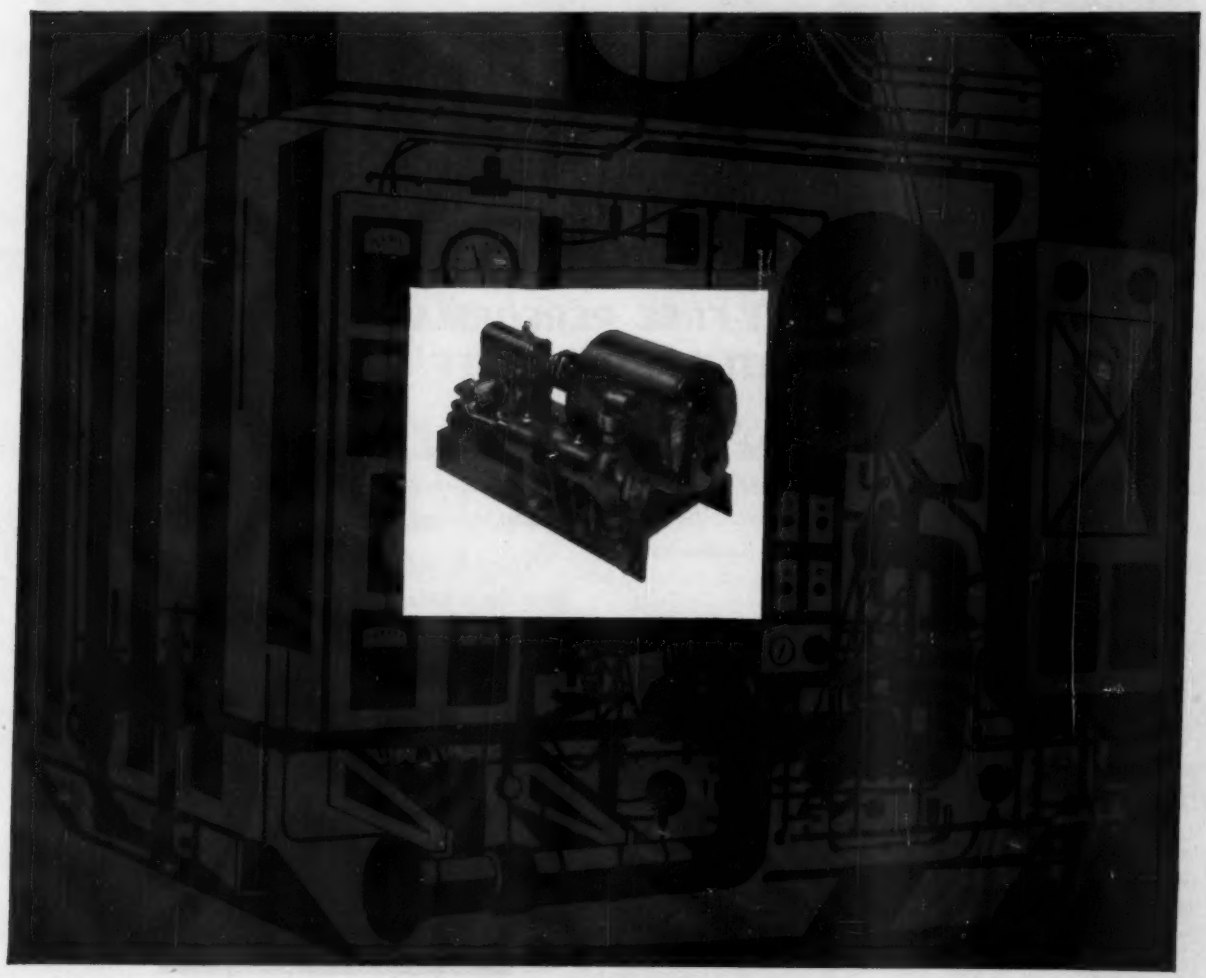
CHEMICAL INSTRUMENTATION SYSTEMS



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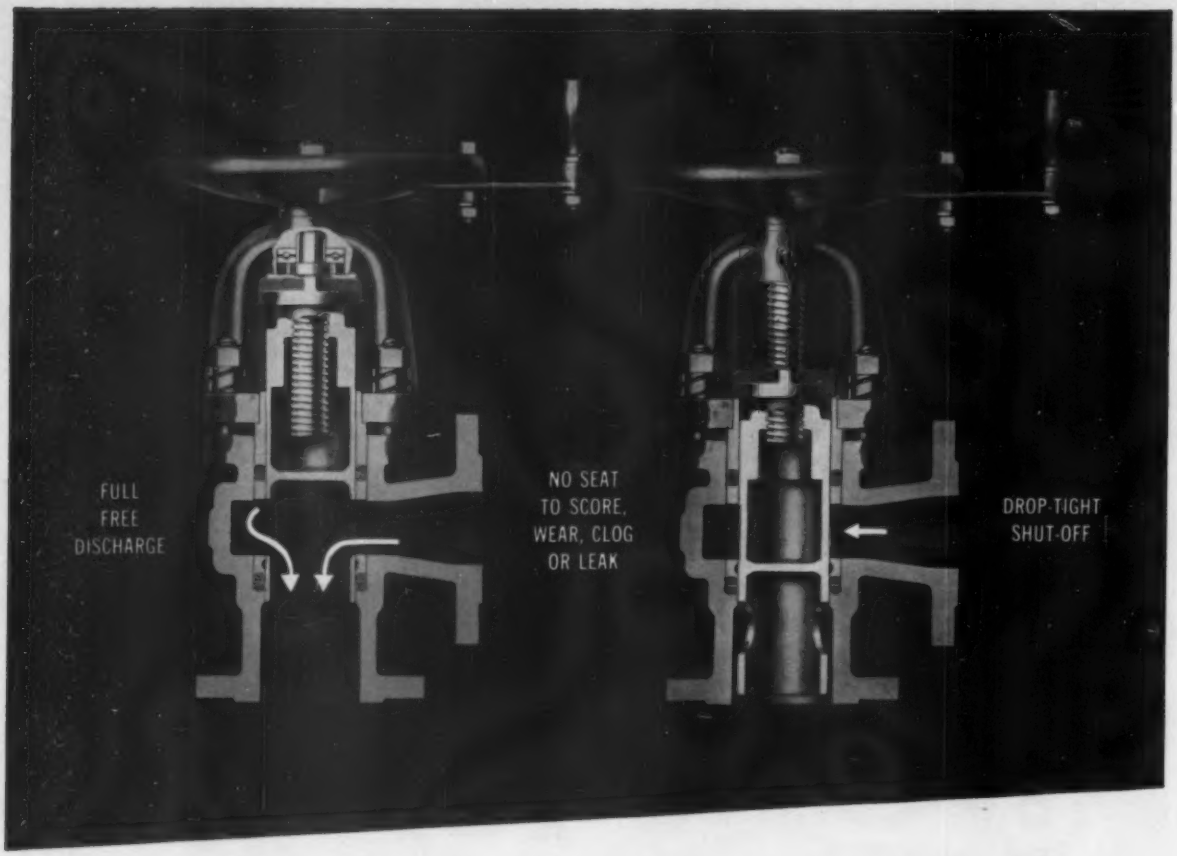

open and shut case!

...FOR TROUBLE-FREE PERFORMANCE WITH YARWAY SEATLESS BLOW-OFF VALVES

Mention Yarway Seatless Blow-Off Valves in more than 16,000 boiler plants, and you'll get solid approval—for these plants have first-hand *experience* with the dependable, trouble-free, service of Yarways.

For boiler blow-down service at all pressures up to 415 psi, YARWAY SEATLESS (in tandem) is the popular choice.

Outstanding feature is the famous seatless design—*there is no seat to score, wear, clog or leak*. Nitralloy hollow sliding plunger permits full, free discharge, yet keeps valve drop-tight in closed position. *No other blow-off valve has these features.*

Specify Yarway Seatless Valves when ordering new boilers and when replacing worn or inefficient blow-off valves on your present boilers.

Yarway Bulletin B-427 gives full information. Write for it today.

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YARWAY
A MARK OF QUALITY IN STEAM ENGINEERING

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TRACERS

Power Engineering's Monthly Probe of Power Facts

Bulb turbines, greatly improved in efficiency, are reviving interest in tidal power generation. Originally conceived as a small unit set in a pressure pipe with a small generator in a bulb surrounded by flowing water, the bulb turbine is longer in a long pipe. Water passages are kept short to reduce friction losses. Bulb containing the generator follows a short inlet converging section, then comes the adjustable blade runner, and lastly a draft tube. Such a unit can operate both ways as a turbine, as well as a pump. Rated output of a modern bulb turbine being tested in France is 9000 kw at a 5-meter head. Watch POWER ENGINEERING for an early article on these machines.

Ontario Hydro announces a $182,000,000, six-year construction program involving three new generating stations and some 450 miles of extra-high-voltage transmission lines (460 kv). EHV here is expected to save millions of dollars in transmitting large blocks of power from remote hydroelectric sites.

Replacing a rotary soot blower with a long retractable type which oscillates so that all blowing steam is directed upwards against the surfaces to be cleaned, has improved boiler cleaning for a plant of Hartford Fibres Co. See page 88 of this issue for details of this unique soot-blower installation.

U. S. is making significant progress with power transformers and inductors which can resist intense heat and nuclear radiation. Contouring hermetic sealing to the core and coil makes a difference; and a very thin ceramic film insulation of nickle-clad copper wire has proved useful to work with ultra-high temperature magnet wires. Report on all this is available from the Office of Technical Services, U. S. Dept of Commerce, Washington 25, D. C. Ask for Report PB 161046, Ultra-High Temperature (500 C) Power Transformers and Inductors.

Use of monomolecular films as a covering to reduce evaporation of water in large reservoirs has been receiving considerable attention. Does this procedure for conserving water supply really work? In his article on page 76, Grant Bloodgood reports the results of Bureau of Reclamation studies of monolayers as used at Lake Hefner, Oklahoma City. Answer to the question is a qualified yes.

Brand new technique for spraying ceramic substances onto a wide range of materials is described by George R. Sylvester in the article on page 97. Process is known as Flame-Ceramics and produces coatings resistant to high temperature, chemicals and abrasion, and having electrical conductivity and insulation, and chemical inertness. One of the first successful applications has been as coating for piston-crowns, valves, and cylinder heads of diesels.

Speaking of gas turbines incorporated into a steam cycle—the major problem now is to learn how to gain maximum benefit from the gas turbine's potentiality, and at the same time, *burn coal*. John Yellott discusses this in an excellent article on page 68.

How Coal Can Fuel the

By JOHN I. YELLOTT
Consulting Engineer

There are many ways in which coal can be burned under pressure, and the products of combustion used to operate a gas turbine. Purpose of this article is to point out some of the little known facts which have been learned during the past 15 years about burning coal under high pressure

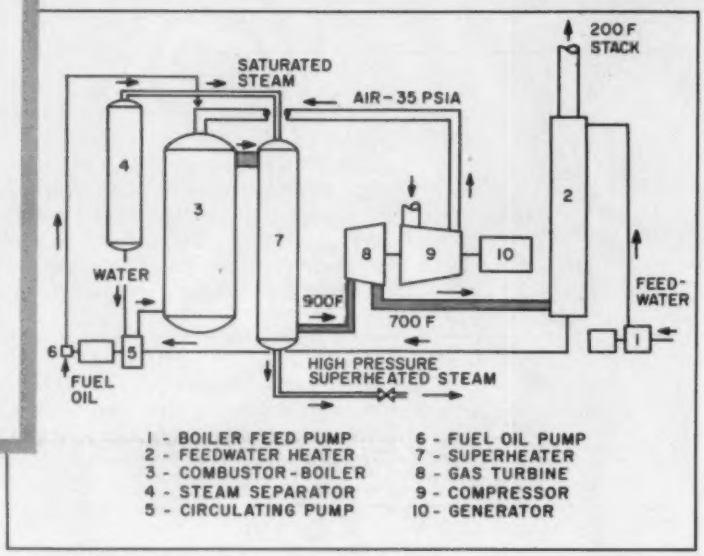


Fig. 1. Velox boiler, turbo-charged to 35 psia by gas turbine, was developed in 1935; it burned oil, not coal, showing an efficiency increase and reduced size

AT THE TURN of the century, coal was almost universally used as the fuel for power station boilers, but by 1930 the fluid fuels had picked up 15 per cent of the load. Today heavy oil and natural gas account for about one-third of the nation's boiler fuel, with coal supplying the remainder.

This trend is likely to be reversed during the present decade, for competitive consumers of petroleum and natural gas are prepared to pay whatever they must to obtain the fuels needed for transportation, domestic and industrial heat, and chemical processes. Public utilities, however, must forsake the convenience of fuels that flow, and seek the greater economy afforded by coal.

Keeping Costs Down

Despite constantly rising prices of every component, the cost per kw of generating capacity has been cut from the turn-of-the-century figure of more than $300 to today's average of about $100 in 1955 dollars. In seeking ways to push station efficiency even higher, and still keep costs from rising, power engineers are taking new looks at old ideas — for instance, the combustion gas turbine, first patented by John Barber in 1791.

Today it has won its way up to a solid position in many applications. When given clean fuel to burn, and properly maintained, the reliability of the gas turbine approaches 100 per cent.

Gas turbines which are available today are much too limited in output to be considered as principal prime movers for utility plants, but it has been found by experience in a number of stations that gas turbines can be incorporated into the steam cycle with beneficial results.

There are many different ways in which this can be done, but the greatest benefits in reducing both fuel consumption and first cost will be attained when the compressor of the gas turbine is used to pressurize the boiler of the steam plant, thus eliminating both forced-draft and induced-draft fans, and reducing the boiler size directly in proportion to the pressure under which the steam generator operates.

This idea, too, is not a new one; the major problem now is to learn how to gain maximum benefit from the potentialities of the gas turbine, and, at the same time, *burn coal.*

How AEP Co Will Do It

The decision to take the first step in this direction for a utility power station has just been announced by the American Electric Power Co and the General Electric Co. In coöperation with Babcock and Wilcox, and Bechtel Corp, a 5000-kw gas turbine, burning pressurized coal gas, will be installed in conjunction with a 215,000-kw steam station. A dual-combustion system will be used, in which the gas turbine will burn the volatile components from a fluidized-bed coal carbonizer operating under a pressure of 100 psi, while the remaining char will be burned at atmospheric pressure in a cyclone furnace.

Burning of pulverized coal under pressures as high as 100 psi was studied in great detail during the 1945–1958 experimental program carried out by Bituminous Coal Research, Inc, and the lessons learned in this work lead to the conclusion that there are many ways in which coal can be burned under pressure, and the products of combustion used to operate a gas turbine.

Velox Boiler Pointed Way

First successful efforts to combine the combustion gas turbine with a pressurized steam generator were made by the Brown Boveri Corp just prior to World War II. Nearly simultaneous developments — axial flow compressors of high efficiency, and alloys which retained high strength at temperatures of 1000 F — were combined in 1935 by Brown Boveri to produce not only the Houdry process gas turbine, but also the "Velox" pressurized boiler.

More than 100 of these units, Fig. 1, were built for use with oil, and their success demonstrated that there were no fundamental difficulties in burning a fuel under pressure and transferring the released heat to

Turbo-Charged Steam Plant

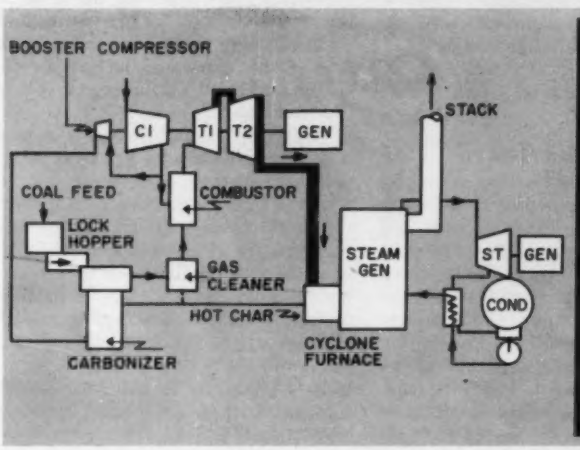


Fig. 2. Partial coal gasification system to be used in Muskingum Station. Black line shows gas turbine exhaust flow

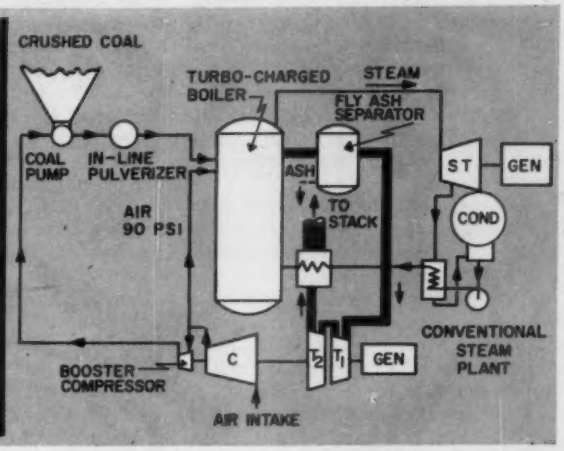


Fig. 3. Direct-fired turbo-charged plant; coal is burned in pressurized boiler, cleaned combustion gas goes to gas turbine

water and steam in a super-charged boiler.

Likewise, the size of the boiler came down in direct proportion to the increase in pressure, and, as long as the fuel was free from ash, life of both boiler and turbine was entirely satisfactory. Some thought was given by Brown Boveri to the burning of coal, but the problems of ash disposal, slagging, and turbine blade erosion caused these efforts to be abandoned.

Other analyses have been made of ways by which the boiler of a conventional steam cycle could be pressurized with the aid of the gas turbine, and in one of these, J. H. Harlowe of Philadelphia Electric Co pointed out that "such a combination would have two important advantages: first, the plant efficiency may be increased by as much as 5 per cent, and second, the size of the furnace will be substantially reduced."

Other studies have been made to show what can be gained by various combinations of steam and gas turbines, but in all of these, it has been recognized that in order to be really successful, such systems must be able to burn coal. The Velox boiler proved that a turbo-charged steam generator was feasible. Today's power engineers must find economical ways of using this principle with coal.

Can coal be burned in a pressurized boiler?* Based on the experience gained during the Locomotive Development Committee's program, the answer to this question is yes. Pulverized coal can be burned at extremely high rates of heat release when pressure in the combustion chamber is raised to six times normal atmospheric pressure. Gasification under pressure has been attempted successfully in many overseas plants. In every case, it is the ash in the coal which causes the problems which, up to the present time, have been almost insuperable.

Based on the experience which has been gained here and abroad, there are at least three practical systems by which coal can be used as fuel for pressurized boilers. Each has advantages and disadvantages, which will be pointed out in the following sections.

Partial Gasification

The system which will be employed in the Muskingum Station of American Electric Power Corp is shown in Fig. 2. In this project, coal will be carbonized under pressure in a fluidized bed, and the resulting gas will be cleaned thoroughly before it goes to the combustion chamber of a conventional General Electric gas turbine.

Small booster compressor will draw air from the outlet of the main compressor, and raise its pressure enough to overcome the pressure drop through the carbonizer. Crushed coal will be fed through a lock hopper into the carbonizer, and the solid residue, together with the dust which is removed in the gas cleaner, will go to a cyclone furnace, where it will be burned in the highly pre-heated air from the turbine exhaust.

A conventional steam plant will be operated from the boiler, and the system has been so designed that it can operate without serious loss in capacity if the gas turbine plant suffers an outage.

The partial gasification system takes advantage of the fact that carbonization, even under pressure, is reasonably well understood today. It avoids the necessity of dealing with the ash in the carbonizing plant, since temperatures here will not rise to the point where slagging will be encountered. Because the gas is under pressure, its volume will be low enough to enable a small gas cleaner to be used, and there should be no unusual difficulties in the gas turbine combustors.

Producer gas, when properly cleaned, has already been found to be a suitable gas turbine fuel, and the blades in the compressor and gas turbine should have adequate life. There is every reason to think that this pioneering undertaking will be successful, although there are sure to be unexpected problems in control, pressuring crushed coal, and so on.

Direct Firing of PC

In order to obtain the full benefits which can be derived from the turbo-charged boiler, all of the combustion should ideally take place under full

* Coal is already being burned in boiler furnaces under pressures measured in inches of water. But here we are talking about pressures of many atmospheres.

pressure. This was done in the original Velox boiler, and it would also be accomplished by the system shown in Fig. 3.

Here, crushed, dried coal would be picked up from a "coal pump" by a stream of conveying air from a booster compressor and carried through an in-line pulverizer into the supercharged combustion zone of the boiler. Fly ash would be removed by a pressurized separator before the products of combustion, still under full pressure, but at approximately 1400 F, would enter the gas turbine.

Exhaust of the turbine would pass through heat recovery apparatus, and then be discharged through a short stack to the atmosphere. Steam from the superheater would go to a conventional generating plant, and the feedwater would be pumped back through the heat recovery apparatus to the boiler.

Principal problem to be solved here is the provision of a fly ash separator of sufficiently high and consistent performance to guarantee the turbine against blade damage from either erosion or deposits.

Experience of the Locomotive Development Committee, and subsequent experience in pressurized catalytic oil refining processes, indicates that, when the fly ash separator does a good job, turbine blade life will not be excessively short.

Ash Separation Problems

Among the many problems which were encountered in developing the combustion and ash separation equipment of the coal-burning gas turbine locomotive, one of the most annoying was the fact that the ash which was separated from the hot gas stream proved to be highly combustible. Because of the short time of residence in a cold-walled combustor, the carbon content of the ash was high. Because of the large amount of excess air which must be used in a conventional gas turbine, there was plenty of oxygen available to burn the remaining carbon.

Both of these problems would be overcome by the system shown in Fig. 3, because the combustion path could readily be made long enough to give adequate time of burning, and the excess air would be reduced to such a low figure that there would be little oxygen left to support combustion of the ash.

Pumping Coal

Coal pump shown in Fig. 3 proved in the LDC experiments to be a feasible way of pressuring coal and its flow. It is reasonable to expect that, through the use of ultra-hard materials, its life would be acceptable by utility standards. The in-line pulverizer developed by the Riley-Stoker Co was successful in pulverizing the coal as it was air-borne from the coal pump to the combustor. Although its power consumption was higher per ton of fuel processed than would be expected in an atmospheric pressure pulverizer, the advantages to be gained from confining the pulverized coal are sufficiently great to encourage the use of this system.

Fly ash separator which was developed in the LDC program was called the "Dunlab" tube, since it was developed in the Dunkirk Laboratory, which was operated for the LDC by Alco Products, Inc. This tube discharges the separated ash in a small side stream, amounting to approximately 1.5 per cent of the total flow. Collection of the separated ash under water proved to be a feasible means of eliminating the fly ash nuisance. Since utility practice usually tries to save every possible Btu, the heat from the blowdown stream would probably be recovered in a simple exchanger.

Concluding test program of the Locomotive Development Committee showed that the final problem in fly ash removal was related to the turbine design, because the ultra-fine ash which escaped the Dunlab tubes passed through the turbine in a laminar layer close to the surface of the rotor. By applying centrifugal force to these remaining particles to throw them out to the blade tips, and by hardfacing the roots of the stator blades, this ash could be made relatively harmless, and adequate blade life could be attained.

It is very probable that the best way to handle the fly ash separation problem in the system shown in Fig. 3 is to incorporate a rotary "ash rejector" in the front end of the turbine. The separated ash would be bled off in a small stream of hot gas which could be cleaned by a battery of small-diameter separators, and then returned to the low-pressure section of the turbine. This combination is likely to be the least costly solution to the most vexing problem encountered in the direct-fired system.

It is the writer's opinion that the cycle shown in Fig. 3 would have many advantages, as far as flexibility in choice of fuels and maximum cycle efficiency are concerned. Problem of ash removal will be solved by an appropriate combination of a separator of good efficiency and an ash-proof turbine.

Complete Gasification

Another system which offers all of the advantages of pressurized combustion and high gas turbine temperature is shown in Fig. 4. Here, coal would be completely gasified in a slagging producer, which would require only steam and low-pressure air. The gas from this producer would be cleaned thoroughly and its pressure would then be boosted by a high-speed centrifugal compressor. Combustion of the clean gas would take place under full compressor discharge pressure, and, after giving up a portion of its heat to the steam generating surface, the gas would proceed to the turbine and thence to the heat recovery equipment in the same manner as shown in Fig. 3.

It might well prove to be less expensive to do the gasification job under full pressure, as proposed in the American Electric Power System, Fig. 2, and in this the gas booster would be replaced by the booster compressor which is shown in Figs. 2 and 3.

Interest in gasification at both atmospheric and elevated pressure has been much greater in England and Europe than in the United States because of the absence of natural gas

Continued on page 112

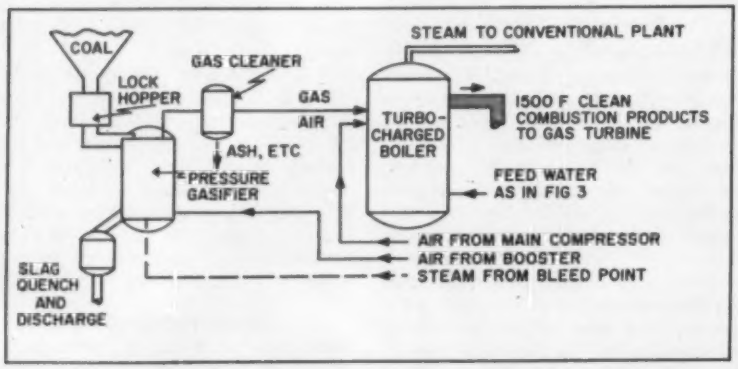


Fig. 4. System using complete coal gasification cleans gas ahead of pressurized boiler in smaller volume than in Fig. 3; there is no need for separation of ash

Schematic showing Hallam nuclear power cycle

Piping for Hallam Reactor Meets Challenge of Liquid Sodium

By RALPH W. FINK* and J. B. VALDESALICE**

MAIN PIPING SYSTEM for the world's first carbon-moderated liquid sodium nuclear power plant now is being fabricated and erected by National Valve and Manufacturing Co. This plant is the Hallam Nuclear Power Facility located near Lincoln, Nebr. Its reactor is designed to produce 75,000 kw.

Challenge of this project arises from the unique properties of liquid sodium that will be the coolant instead of water, which has been used in the major nuclear reactor power plants built to date.

An excellent thermal conductor, sodium melts at 208 F into a silvery white liquid that has viscosity one-third that of water. Sodium's low viscosity causes it to leak through the minutest cracks. This undesirable characteristic must be overcome in the design, fabrication and inspection of the power piping system.

As a safety precaution, the primary sodium loop is covered with guard piping that leaves a 2-in. gap between the two sets of piping. This space is evacuated of atmospheric gases and charged with helium gas. In addition, the primary loop is in a pipe gallery that is isolated by a metal envelope and concrete. The entire envelope containing the primary loop is subjected to a slightly positive helium atmosphere.

To keep the liquid sodium from solidifying during the initial start-up process, a system of strip heaters will be attached to the pipes to keep the temperature above 350 F.

Primary and secondary piping systems are fabricated from Type-304 stainless steel. Guard pipe assembled over the sodium coolant piping consists of 1¼ per cent chrome moly steel.

In addition to this piping, NAVCO also is responsible for the fabrication of 14 sodium storage tanks for the secondary system. These are made of Type-304 stainless steel to ASME code requirements.

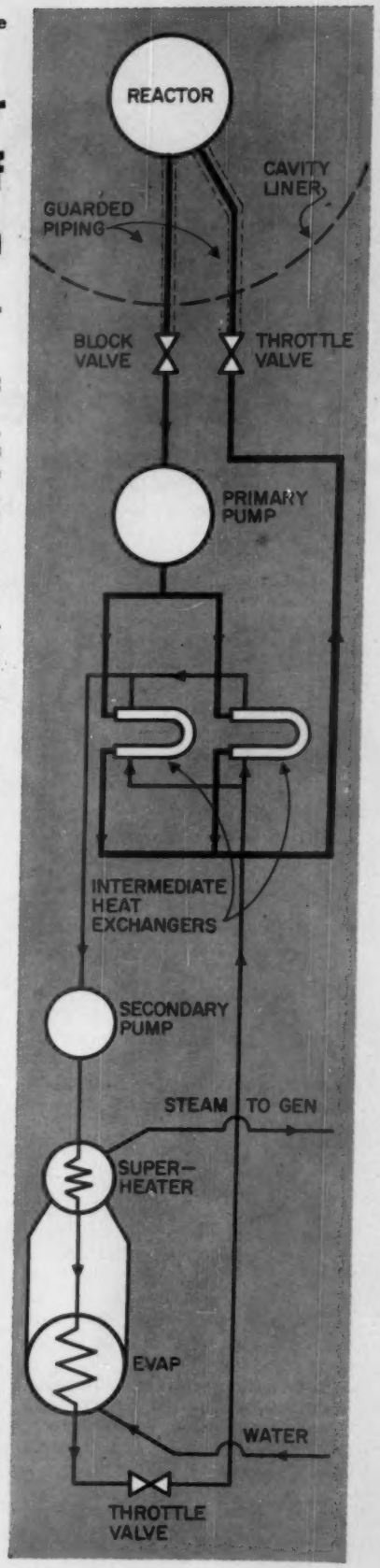
There are also three unusual 30-in. expansion joints at the gallery seals and six 30-in. expansion joints at the pipe seals. All of these expansion joints will be capable of withstanding high torsional forces, large lateral movement and within a low axial force. Counterpoise hangers will be used, which provide constant support during long travels.

There are more than 2300 welds in the assembly of the piping. Root pass for stainless piping fabrication is done with the heliarc welding technique to insure a high degree of control and preclude the possibility of oxidation and contamination. Heliarc welding technique consists of filling the interior of the pipe with an inert gas (argon) and also providing an argon gas shield on the seam during welding.

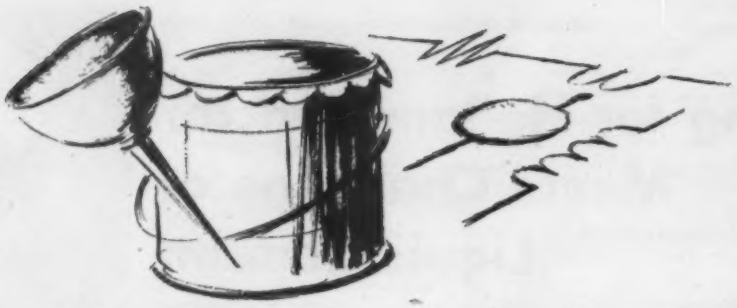
Every stainless weld undergoes a dye-penetrant inspection and X-ray examination to insure against flaws. Then a helium leak test is performed on all stainless welds in the containment envelope. This consists of creating a vacuum inside the piping assembly and probing the welds with a jet of helium gas. If there are any cracks for the helium to enter the vacuum, this will register on a helium detector so sensitive that it will detect leakage equivalent to the rate of one drop of air in six years.

Special handling and extraordinary cleaning procedures are required both during the fabrication and erection. Painstaking inspection is made to insure against contamination. Both the inside and outside of the stainless piping assemblies are sandblasted or pickled to a satin finish.

Pipe erection began in October, 1959, and is scheduled for completion by March, 1961. End of total construction on the project is scheduled for July 31, 1961. THE END



* Chief Engineer, and ** Chief Project Engineer, National Valve and Mfg Co



What Is Proper Lubrication for Your Electric Motor Bearings?

Different bearing types require different construction for proper lubricant, whether grease or oil. Here are the details, with comment on how the lubricant should be used on each type of bearing

By R. L. NAILEN

Motor Engineering Section, Manufacturing Div, Westinghouse Electric Corp

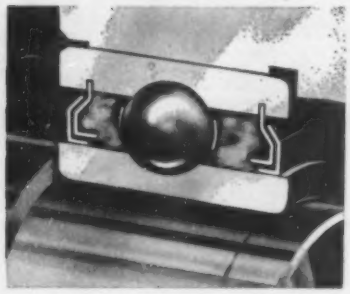


Fig. 1. Cross sectional view of pre-lubricated, sealed ball bearing, showing the two inner and two outer seals

BEARINGS of several types — ball bearings, roller bearings, sleeve bearings, thrust bearings — are used on electric motors, as described in the May, 1960, issue of POWER ENGINEERING, page 71.† It is important for the power engineer, when specifying and using motors, to understand these bearings, their uses, and their life expectancy.

Reason: engineers often tend to think of the electric motor as primarily an electrical machine; but it is at the same time a mechanical device because of its rotating parts. Hence, many of the problems that arise in operating it involve the bearings, and an important factor in getting top motor performance and maximum bearing life is proper bearing lubrication.

How are these bearings lubricated? Let's look at the ball bearing first. General-purpose horizontal motors use grease lubrication, and in smaller sizes this is available two ways: the pre-lubricated and sealed bearing, and the regreasable bearing. Some motor manufacturers offer both types.

The first type, Fig. 1, is a single-row radial bearing with races of double row width. The extra width is used to contain an ample supply of grease, plus a combination of rotating and stationary seals that keep the grease in the bearing and shut dirt out. The grease is put in at the bearing factory, so it is always of the right grade, the right amount, and is always clean. No further lubrication is needed for the life of the bearing. This type of bearing is not currently available in sizes above No. 315.

Regreasable Bearings

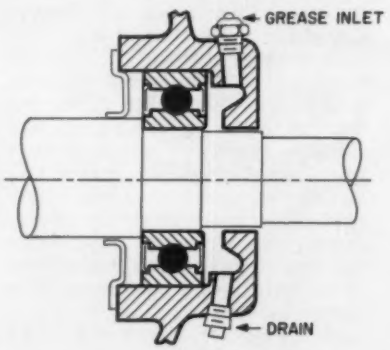
Regreasable bearings, Fig. 2, must be relubricated occasionally, and here are the two cardinal rules to follow:

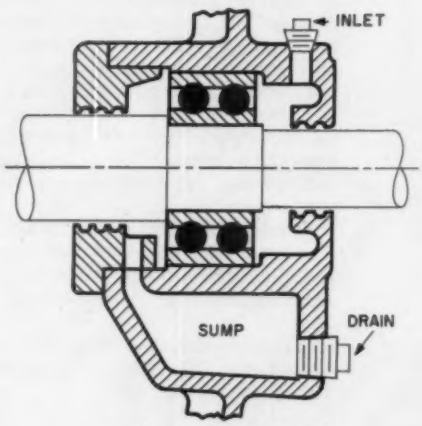
1. Don't put in too much grease.
2. Don't let any dirt get in along with the grease.

How much is too much? Service experience must provide the final answer, but here is a guide, used successfully for many years:

Motor shaft extension diameter, inches	Amount of grease to be added	
	Wt., oz.	cu in.
¾ to 1¼	½	½
1¼ to 1⅞	¾	1
1⅞ to 2⅜	1	1½
2⅜ to 3	1½	2
3 to 4	2½	3
4 to 5	4	5

Purpose of adding grease is to replace grease that has leaked out (which should be negligible) and to replace deteriorated or dirty grease with fresh grease, by forcing the old lubricant out through the bearing. If the motor is operating in clean air, at an ambient temperature below 100 F, and the bearings are lightly loaded, the addition of new grease may not be necessary for several years. When





† A future article by this author will tell how to determine the best bearing for the job, how to get best results with it, and also what to do to prevent bearing failures.

these conditions do not apply, regreasing may be required much oftener. Unless experience with the application dictates otherwise, the safest course is to add the small amounts of grease at least once a year and observe the result.

Too Much Grease = Trouble

When the bearing gets too much grease, the grease gets in the way of the rolling elements, and the churning of the grease causes overheating. This in turn accelerates breakdown of the lubricant and subsequent failure of the bearing. Also, grease may escape along the shaft, collect on motor windings, and cause insulation breakdown. At low speeds, in very dirty locations, an oversupply of grease may be advantageous — it does tend to keep dirt from getting in along the shaft. But in general, it is risky.

Maintenance men, finding a bearing that is hot due to overgreasing, may add grease to cool it down, and so aggravate the trouble. To avoid this, it is wise to make sure that the grease relief or drain plug is open when grease is added. The surplus can then escape and leave a little room in the bearing housing so the bearing can free itself of a temporary excess.

Even under the best conditions, grease will deteriorate eventually. A proper lubrication program will therefore include a periodic complete cleaning out of the bearing housing to remove all old grease. This should be done at least once every two years, unless service conditions or manufacturer's recommendations dictate otherwise. Complete disassembly of the bearings, and long down-time, may be put off to longer intervals if the motor design is one having a large grease sump that will collect old grease forced out of the bearing at relubrication, as shown in Fig. 1. Cleaning out the sump occasionally will remove deteriorated grease.

Type and grade of grease recommended by the motor manufacturer should be used. Use of the wrong grease may cause overheating, leakages, and rapid deterioration.

In some 3600-rpm motor designs (200 to 700 hp) journal speeds are too high for grease lubrication to function effectively. Oil-lubricated ball bearings may be available in such cases, but this point should be negotiated with the motor manufacturer.

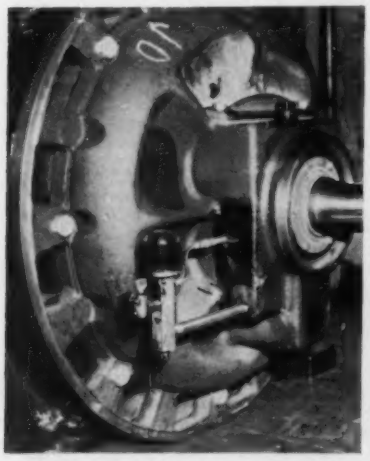


Fig. 3. Constant level oiler bottle assembly — as applied to a large and totally-enclosed sleeve-bearing motor

Fig. 2 (at left). A view of two typical regreasable ball bearing assemblies

Sleeve Bearings Take Oil

Oil lubrication is the rule with all sleeve bearings. Whereas an excess of grease or oil is harmful to ball bearings, due to churning, an oversupply of oil does no harm to a sleeve bearing itself. However, it is wasteful, and is likely to cause leakage of oil into the motor. Oil should be added to the bearing housing only when a deficiency is indicated by a drop in the oil level below the normal value.

To make sure of restoring the correct level, the oil should be added when the motor is idle. Normally such addition should not be required more than once or twice a year. At longer intervals, a complete oil change is called for. Need for this is best determined by periodically draining off a little oil and checking it for dirt, discoloration, and acidity.

Some motor users feel that holding the correct oil level, in locations difficult to get at or seldom visited for maintenance, is made easier by ordering the motor equipped with constant-level oilers as in Fig. 3. These automatically restore the loss of small amounts of oil from the bearing housing; visible presence of any oil at all in the oiler bottle is a sign that the bearing requires no addition.

Some discretion should be used in ordering these devices as a motor accessory. The normal capacity of the oiler bottle is only a few ounces, to replace small quantities lost through leakage over a period of time. It is unrealistic to request that such a device be supplied to maintain oil level on a large motor with a bearing housing containing several gallons of oil.

The means for checking oil level, on motors not equipped with oilers, may or may not be a visual sight glass. Smaller oil-lubricated motors may have only a fill plug. In some applications, it may not be possible to check oil level at shutdown, and opening the fill plug while the motor is running may result in loss of oil due to pressure differentials, as well as a misleading reading of the level. Such motors should be ordered equipped with sight gages.

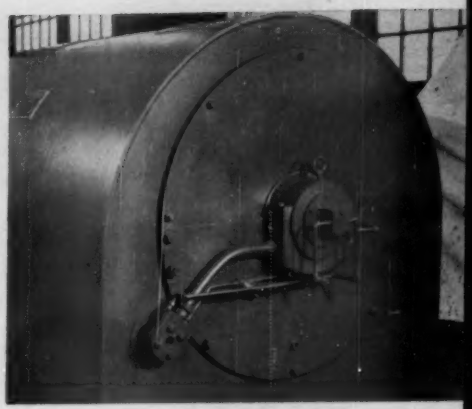


Fig. 4. Forced lubrication system on large, base-ventilated 3600-rpm sleeve-bearing induction motor. Oil reservoir (at lower left) extends longitudinally through motor frame, is cooled by an incoming, ventilating air stream

Many conditions of load, bearing operating speed, and bearing types make it advisable to follow the recommendations of the motor manufacturer as to the grade of oil to be used in any given motor.

Lubrication of most sleeve bearings is by oil ring alone. However, large high-speed motors with high values of journal rubbing speed (usually 3600 rpm only) are commonly supplied with forced lubrication systems in addition to rings. A constant flow of oil is pumped into or over the bearing, either from a shaft-driven oil pump, Fig. 4, supplied by an oil reservoir in the motor frame, or from a pressure system external to the motor. When the pump is self-contained, it is, of course, inoperative at the critical moment of starting — before proper oil film has been built up in the bearing. From this it can be seen that the primary function of the pumping system is not the reduction of friction and wear but the cooling of the bearings. A pump breakdown will not usually cause premature bearing failure within a short while, but will raise the bearing temperature slightly.

THE END

MORE TO COME...

How We Modernized Our Plant And Saved Money

By MARVIN BUHNER*

IN PAPERMAKING, as in all other competitive fields, quality products are the result of capable personnel performing their assignments efficiently with good equipment. When we of the Fox River Paper Corporation recognized that our 40-year-old coal-burning steam plant in Appleton, Wisconsin — though still serviceable — was not producing steam as economically as desired, we decided to make an owning and operating cost survey to check this observation.

Preliminary investigations revealed that modernization of the existing steam generators was impractical because of the age of the equipment. A survey and analysis report prepared by a firm of consulting engineers contained recommendations for the installation of a new 60,000-lb-per-hr steam-generating unit, operating at a pressure of 615 psig (superheated), and a 3000-kw turbine generator set. Total estimated cost was $1,310,000.

According to the consulting engineer, outlays of $178,900 for building remodeling and $91,400 for modernizing the coal- and ash-handling systems were required if coal was to be retained.

These investment costs gave management considerable concern and led to our investigation of the economics of other fuels as well as the continued purchase of electric power. Manufacturers of oil- and gas-fired package boilers claimed a labor savings of $23,500 would be possible with gas or oil by reducing the present operating force from nine men to four, whereas they claimed all nine men would have to be retained with a coal-fired plant!

We proceeded to make a careful analysis and comparison of available fuels, steam-generating equipment, fuel handling, storage, and labor requirements, as well as owning and operating costs.

Fuels

Annual coal costs for the old plant approximated $147,000 with an estimated over-all efficiency of 64 per cent. Based on an equivalent steam use, but considering the increase in efficiency that would be gained with new equipment, the annual coal costs were calculated to be $103,500. (In 1959, which had one of the coldest winters on record, the actual coal costs amounted to $107,292.92.) Heavy fuel oil would have cost $192,000, a cost difference totaling about $84,700 a year in favor of coal.

The most difficult decision was in the area of labor allocation for the new plant. Fuel oil proponents were adamant in their position that the existing operating staff of nine men could be reduced to five with the use of oil, but that no labor savings could be realized with modern coal-burning equipment. Rational approaches to realistic staffing requirements by representatives of the C. Reiss Coal Co, substantiated by case histories from Bituminous Coal Institute, indicated that modern coal-burning plants in this category are being operated with one attendant per shift.

Subsequent actual experiment at this plant has proved that the modern coal-burning facility is adequately staffed with four operators, the same manpower that was claimed to be possible only with oil. The claimed labor differential does not exist.

Owning, Operating Costs

A summary of the detailed analysis indicated that: 1. a decrease of approximately $50,000 per year in operating costs could be effected with a new boiler and stoker installation

*Fox River Paper Corp, Appleton, Wisconsin

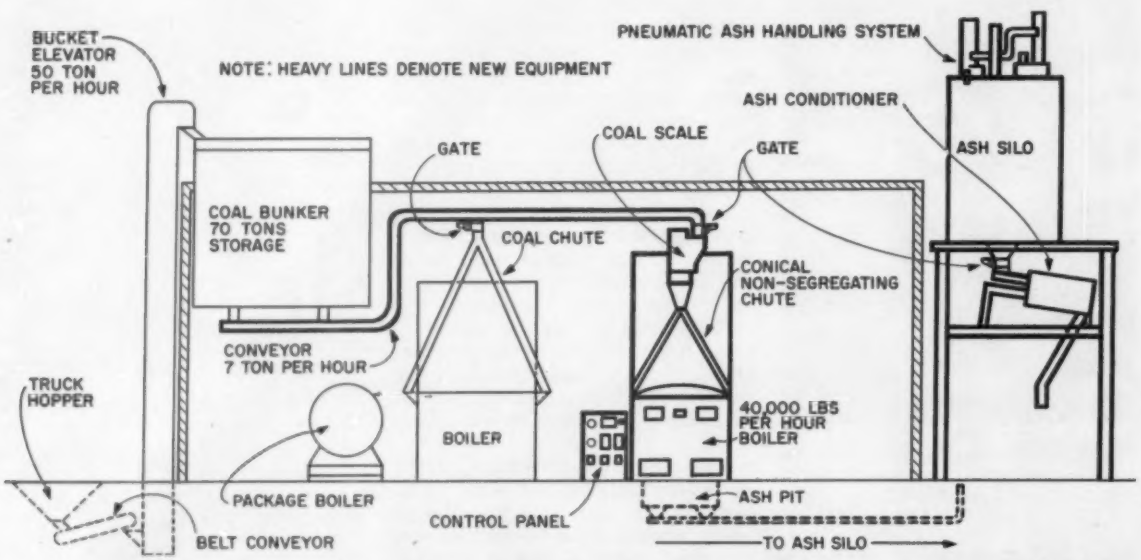


Fig. 1. Addition of new plant equipment was located to make best possible use of plant facilities common to both boilers

replacing the present equipment; 2. operating cost with a new coal-fired unit would be approximately $70,000 per year less than with a new oil-fired unit; 3. the difference of approximately $45,000 in the first cost of the coal-fired equipment over the oil-fired equipment could be amortized in about two years from the net savings in owning and operating costs; and 4. the net savings could amortize the entire coal-fired plant investment in about eight years. (It is interesting to note that the 40-year-old coal-burning plant is more economical to operate than the proposed new oil-burning plant.)

Steam-Generating Equipment

The old plant consisted of one B & W 500-hp Stirling boiler, installed in 1915, and three 300-hp Wickes vertical watertube boilers, installed in 1920. Boilers were operated at 150 psig and fired with Murphy V-type natural draft stokers.

Average steam requirements approximated 32,000 lb per hr with peaks of 45,000 lb per hr for two to three hours during the winter. No significant changes in the steam requirements were anticipated in the near future.

Various equipment changes were considered in modernization planning, including restokering, installing oil burners in the existing boilers, installing field-erected and factory-assembled coal-burning boilers, and installing two factory-assembled and package-type oil-burning boilers. (One manufacturer offered a multiple 250-hp package-boiler installation.)

Detailed analysis of owning and operating costs indicated that the most economical plan of action was to retain coal and to modernize the plant. Therefore, it was decided to purchase a new coal-burning boiler for continuous duty, retain the Stirling unit for emergency use, and relocate an existing 12,000-lb-per-hr package-boiler unit for use during holidays, weekends, and other periods of minimum steam demand.

The new boiler selected was a conventional two-drum, bent-tube type with a water-cooled furnace, operating at 150 psig saturated and having a continuous-duty capacity rating of 40,000 lb per hr, with a 45,000-lb-per-hr overload rating to take care of the peak demand requirements, Fig. 1. The boiler is fired with a Vibra-Grate stoker and equipped with complete combustion controls for automatic operation, Fig. 2.

The fuel cost survey disclosed that truck-delivered coal could be purchased as economically as rail-delivered coal, so it was decided to discontinue the practice of receiving coal by rail. This decision resulted in a labor saving as well as the saving involved in modernization and maintenance of the equipment involved.

Fig. 2. Control panel (right) controls combustion, makes operation automatic

Fig. 3. Good silo and hopper capacity aid this pneumatic ash-handling system

Coal is now delivered by truck to a hopper, from which it is elevated to the overhead storage facility. This operation requires only part-time attention by one man.

A flight conveyor, 12 in. wide, feeds the coal from the bucket elevator to an existing 70-ton overhead bunker. Coal is moved from the bunker to the new boiler through a 7-ton-per-hr, 7-in.-diameter, mass-flow type conveyor over a coal scale.

An 8-in.-diameter pneumatic ash-handling system was installed, and adequate hopper and silo capacity was provided to permit operation by one man on a part-time basis, Fig. 3.

Owning, Operating Experience

Detailed surveys and analysis paid off for Fox River Paper Corp. Actual total costs were $213,465, including new water-conditioning and deaerating equipment. No building remodeling or major foundation work was required. Compare the total modernization cost with the consulting engineer's original estimate of $270,300 for changes to building and coal-handling equipment alone! THE END

Breakdown of the Total Cost of the New Boiler Equipment

Boilers	$ 71,261
Stoker	27,720
Installation	24,871
Total steam generation	$123,852
Coal handling	8,614
Ash handling	9,736
Installation and silo	13,300
Total coal and ash handling	31,650
Combustion controls	7,407
Foundations	28,146
Water softener, deaerator feed pumps	6,966
Miscellaneous	5,224
Electrical supplies	744
Engineering	9,476
GRAND TOTAL	$213,465

The plant is now operating efficiently with one operator per shift, plus a utility man assigned to the day shift only. This five-man total exactly coincides with the labor requirements estimated for the proposed oil-fired installation.

In addition to the annual savings outlined above, last year's maintenance costs for the new installation were 53 per cent less than required for the old plant. In substance, an annual saving of more than $11,000 in maintenance costs alone was achieved.

U. S. Air Force photo, 1958

Water stored in reservoirs can be protected from evaporation loss by the application of a monomolecular layer forming an invisible shield between water and surrounding air of about 6 ten-millionths of an inch thick. This view of Lake Hefner at Oklahoma City shows such a film being applied. Film is the light area along right shoreline. It reduced evaporation 9 % in 3-month test

Are Monolayers Practical as a Means of Conserving Water Supply?

By GRANT BLOODGOOD*

ANSWER to the above question is a qualified "yes," if we consider the results obtained thus far by the Bureau of Reclamation and coöperating agencies in their studies of evaporation reduction from large reservoirs through the use of a film-forming chemical on the water surfaces.

The qualification is stated advisedly. Although investigations to date have demonstrated that film-forming techniques are available to reduce evaporation, much research remains to be carried out before the chemical films can be considered practicable in conservation of reservoir waters for hydroelectric power, irrigation, and other purposes.

One of the films the Bureau has had under study is formed by the compound hexadecanol, also known as cetyl alcohol. When hexadecanol is spread on a water surface, it forms a film or monomolecular layer — an invisible shield between the water and the surrounding air, one molecule or about 6 ten-millionths of an inch thick. The layer forms because the molecules align side by side, the hydrophilic, or "water loving," end in the water and the hydrophobic, or "water fearing," end in the air. The alignment is similar to paper matches in a matchbook and forms an invisible and pliable layer on the water surface, which restricts escape of water molecules to the surrounding air.

* Assistant Commissioner and Chief Engineer, Bureau of Reclamation, Denver, Colorado

Following extensive laboratory investigations carried out in the Bureau's engineering laboratories in Denver and preliminary field trials at several reservoirs in Colorado, a comprehensive coöperative experimental study was made at Lake Hefner, Oklahoma City, Oklahoma, during July 7 through October 1, 1958.

The coöperative investigation was undertaken by a committee of collaborators which included representatives from the City of Oklahoma City; Oklahoma State Department of Health; Public Health Service, Department of Health, Education and Welfare; Weather Bureau, Department of Commerce; and the Geological Survey and the Bureau of Reclamation of the Department of the Interior.

Lake Hefner is a municipal water supply reservoir about 2500 acres in area and a part of the water supply system for Oklahoma City.

In June, 1959, a final report by the committee of collaborators was issued giving the results of the study. The report indicated that techniques were available to cover Lake Hefner with a fully compressed layer of hexadecanol, given favorable conditions. Methods developed as the result of research in recent years were used to measure the actual evaporation and to compute the evaporation that would have occurred normally.

The Geological Survey's evaluation showed that during the period of treatment an over-all reduction in evaporation of slightly more than 9 per cent was achieved even though weather conditions frequently were not favorable for maintaining the film. For short periods of approximately one week, evaporation savings up to 14 per cent were accomplished.

The report further stated that the effectiveness of evaporation retardants is lessened at higher temperatures, and the 9 per cent reduction achieved is about one-fourth of the potential reduction with the kind of material used at Lake Hefner and at the water temperatures experienced. Use of such improved materials and methods would result in an increase in the amount of water saved.

The monolayer-forming compound applied to Lake Hefner was a dry powder mechanically mixed with water and sprayed onto the surface of the lake. Applications, weather and other conditions permitting, were made during the daylight hours, seven days a week. Later in the summer, an effort was made to have the greatest film coverage coincide with the time of highest evaporation. During the summer, a total of 40,040 lb of cetyl alcohol was applied.

The cost per acre-foot of water saved range from about $58 to $86, with an average for the entire period, July 7 to October 1, of $61.21. This compares with a value of raw water in Lake Hefner of about $60 per acre-foot.

The costs of hexadecanol were 73.5 per cent of the total costs. Based on discussions with manufacturer's representatives, it is anticipated that material costs may be reduced at least 50 per cent. THE END

Chemicals Can Keep Right-of-Way Brush Clear

Cutting brush on utility rights-of-way is a never-ending process. Chemical treatment on brush simplifies the job, costs less. Here is Central Maine Power Co's recent experience with chemical control

By CLARENCE E. STAPLES*

FIGURES 1 and 2, based on Central Maine Power Co's transmission spraying program, represent a sample mile of new transmission right-of-way. Basing our predictions on current costs, we find that this mile of right-of-way would cost us approximately $10,000 to maintain by cutting, over the 28-year period, and with an end result far from satisfactory. On the other hand, we would expect to spend approximately $6000 over the same period to maintain this right-of-way by the use of chemicals — a 40 per cent saving, with a far more satisfactory result.

Recent analysis of our records indicates that we may expect slightly higher future savings, approximately 45 per cent, when our entire transmission system is taken into consideration. And for every dollar a utility company saves through the use of a more economical method, there is a relative benefit to the ratepayer.

Our distribution, or roadside brush control program, has been of much shorter duration and it is therefore much more difficult to arrive at conclusive figures. However, based on our experience to date, we feel safe in predicting an equal, if not higher percentage of savings in our roadside brush control work. Main reason for a higher percentage prediction is the accessibility of roadside brush to spraying equipment.

Here's a good example: we cut 122 miles of medium roadside brush at a total cost of $13,900, or $114 per mile. We sprayed this same 122 miles one year later, for a total cost of $3100 or $25 per mile.

Our current practice is to spray brush two years in a row in order to control the higher brush on the first application, and the smaller underbrush on the second. In most cases, after two sprays the brush is nearly all eliminated and may be left alone for the next two or three years. At this time we would plan to spot-treat only, which would avoid the long unbroken strip of brown leaves which is so objectionable in appearance after the first two treatments.

We feel that at least a 50 per cent saving is a sound estimate for our use of chemicals to control roadside brush.

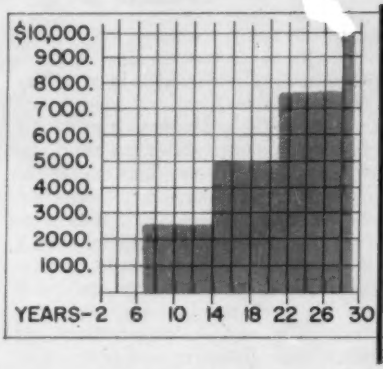


Fig. 1. Cost of cutting on 7-year cycle per mile of 150 ft of transmission r/w

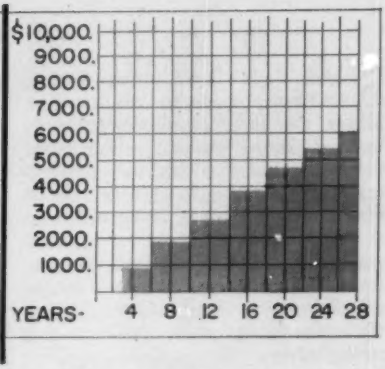


Fig. 2. Cost of spraying same r/w on 4-year cycle results in saving of 40%

The chemical used by the Central Maine Power Co in all its brush control work is 2,4,5-T. We use this chemical mixed either in water or in kerosene or fuel oil. Water mixture is three quarts of 2,4,5-T in 100 gallons of water. This is used for initial roadside spraying work. Kerosene or fuel oil mixture is four gallons of 2,4,5-T in 96 gallons of kerosene or fuel oil. This is used for spot-treatment of roadsides and for all spraying done on transmission rights-of-way. The transmission spraying is selective and is applied with knapsack sprayers.

Ultimate roadside spot-treating will be done with either knapsack equipment or power-based equipment. The initial spray work on roadsides, as already indicated, is a water mixture and is not selective, but rather is called a blanket application. In general, the brush along roadsides is too thick to make selective treatments economically feasible until a fairly high percentage has been eliminated by the blanket spray method.

Conditioning the Public

A successful brush control program, especially one which involves roadside spraying, must be coördinated with such organizations as the garden clubs, fish and game commission, highway commission, nature clubs, and, of course, the general public. The economic savings to all are of great importance, but not enough of an argument to sell dead brush along a highway to everyone.

Fortunately, the hormone-type sprays, of which 2,4,5-T is one, in normal usage are harmless to all forms of animal life. Nevertheless, the public must be informed of this fact.

There are three conditions which are of utmost importance to the success of any chemical brush control program. They are:

1. Make sure the public knows that the chemicals are not poisonous.
2. Make it plain that the dead brush is only temporary and will be replaced by more desirable and attractive forms of plant growth.
3. Avoid the spraying of roadside brush which is over six feet or so in height, since it may not fall over for five or six years and is a constant source of irritation to those motorists who are interested in a green roadside.

Nearly all of the larger tree expert companies throughout the United States have gone into chemical brush control work. These companies are well qualified either to assist a utility company in setting up a program or to do the actual work on a contract basis.

Technical information regarding chemicals to be used, etc, may be obtained from State universities, U. S. Department of Agriculture, Weed Society of America, or from the proceedings of any of the four regional weed control conferences held annually at various places in the United States.

THE END

*Brush Control Engineer, Central Maine Power Co

How You Can Save On Power Costs

By ELMER GATES *

SOME SERVICES that electric utilities provide cost more than others, and it is common practice to have different electricity rates for different classes of service. Accordingly, a power engineer wants to be sure that his plant is being billed on the most favorable rate, or in some cases, combination of rates. Also, to make certain he has taken advantage of all possible operating economies under the rate, or rates, at which he is being served.

Due to the complexity of electric rates, outside experts (as well as power company representatives) have been able to find ways of reducing purchased power costs. Where outside experts are hired, they either participate in the savings or obtain a fee. Normally, these savings to the customer could have been realized without the payment of a fee to a third party. It is the intent herein to indicate some of the ways in which these savings may be obtained — by dealing directly with local utility representatives.

Industrial customers are constantly developing new programs and rearranging operations. This may make one rate more favorable to them than some other rate on which they were previously served. Because of this, it is impractical for utilities to guarantee that all customers will be billed on the best rate at any particular time. *The responsibility rests on the customer's shoulders.*

Not only are electric utilities required to publish all of their rate schedules, but in addition, most of them provide a staff of power sales representatives to aid customers in obtaining the most favorable rate. These power specialists are available to advise customers which optional rates are applicable, and to assist them in making rate calculations. It is not uncommon for a power sales representative to spend half of his time working with customers to find the most economical way for the customer to purchase power. Some utilities set up periodic rate audits to determine appropriate rate applications.

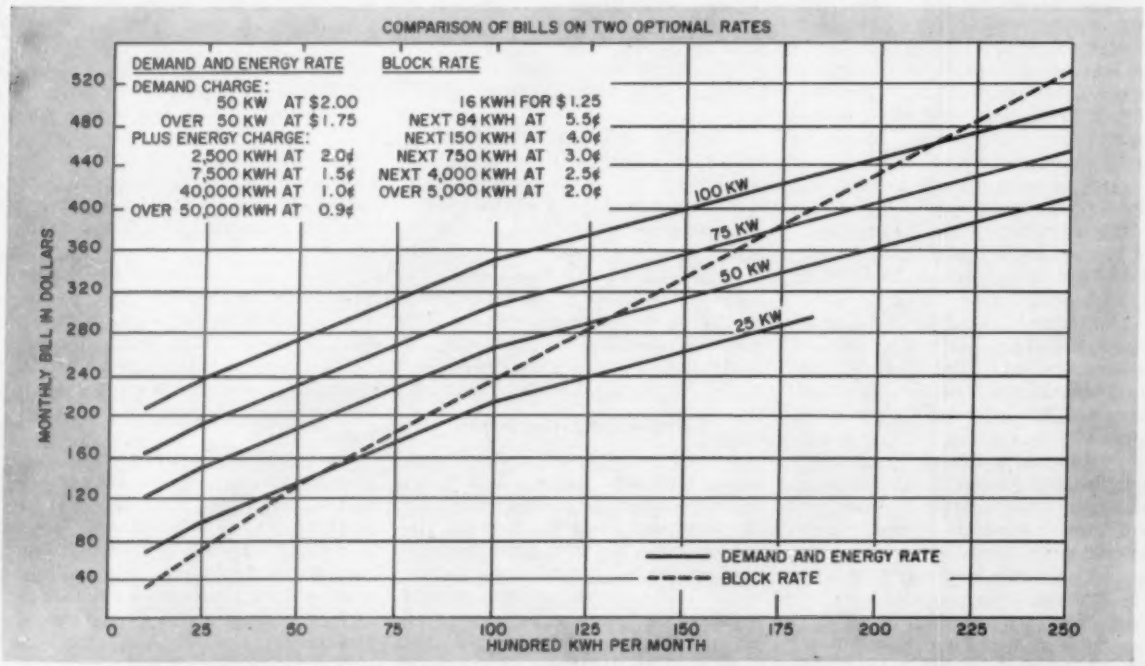
Optional Rates

As mentioned, most utilities have more than one rate applicable to commercial and industrial service. A common procedure is to have a simple block rate for the smaller commercial customers (with relatively higher prices per kwh), and then one, or more, so-called *demand and energy rates* for higher-usage customers. In this way the customer using his equipment longer hours benefits with a lower rate. A demand and energy rate is one which provides for a separate capacity charge, based on the kilowatts of load. The demand portion of this rate is based on the greatest use in a 15- or 30-minute period, as measured by a demand meter. See the graph below.

We heard of a case recently where a power engineer wrote in, asking how much his bill would be on the *second* best rate. He was paying $20,000 a year; the utility calculated his bill on the other rate and found it would be $25,000.

Another case concerned an animal by-products plant. This plant had about 90 kw of load, with a use of 30,000 kwh per month at a cost of

* Manager, Rate Dept, Middle West Service Co



Graph shows how you can save on power costs by applying one of the two rate-billing systems according to your requirements

$6800 per year. It had been a small plant, and as it grew it remained on the *general-service* rate. Through a rate audit by the utility, it was found that the application of one of its optional rates resulted in a 10.6 per cent saving to the customer. As is customary, and in this case, it was the customer's obligation to inform the utility of changes in load. And had he done so, his savings would have been greater, since they would have accrued over the period prior to the rate audit.

Off Peak Provisions

Some utilities have found it profitable to establish off-peak hours, during which large industrial concerns can operate their load without being charged full demand costs. This is exemplified by three-shift operation, where high demands can be transferred to the swing, or night, shift. If the utility has such a rate, it is well to investigate the possibility of its use.

An example of off-peak operation involved an ice-manufacturing plant which, by operating at night, could reduce the demand charge $100 per month. The rate provided that for every kw operated off the daily peak (between the hours of 9:00 P.M. and 9:00 A.M.), the demand charge was waived, and the energy was charged at only 7 mills per kwh. This operation enabled the customer to save $27 per kva annually.

Another way to reduce the demand charge is to limit the peak load. It is sometimes possible for a plant to reduce this peak capacity by staggering plant operations. The power engineer may arrange to stagger operations in different departments, so that they do not create an accumulated electrical peak at any one time.

For example, in a machine shop, all of the tooling equipment need not necessarily be operating at the same time. Sometimes it is possible to stagger operations, thereby substantially reducing the total demand requirement. By so doing, operation of individual motors would be staggered, and at the same time motors could be more accurately sized, thus reducing the total energy requirements.

An excellent example of this control of *peak use* occurs in oil fields, where oil-well pumping is limited by government control of production. Here, automatically, different wells may be controlled to come on at different times in order to avoid pyramiding of the loads.

Another case we heard about concerned a coal mine which had a 40-gpm pump. It was used only rarely for pumping water seepage from the mine. By operating this pump when the coal hoist and car machinery were off, the maximum demand could be reduced by the full load of the pump, thus saving a substantial charge.

Power Factor Correction

It is common practice for utility companies to have a power-factor clause in their industrial rates. This clause generally provides for a penalty, if the power factor is not up to the average of 80 or 85 per cent *lagging;* or it may provide a *bonus* if the power factor exceeds 85 per cent. It is well to find out if the utility has such a clause in its schedules. It may be possible by the purchase of power-factor corrective equipment to obtain a somewhat lower cost. There are many instances of this type of saving.

A wall-board manufacturer was able to pay for the cost of capacitors installed, from the savings realized on his electric bill, in the first two years after installation.

In another case, an investment of $5125, for the installation of capacitors, was recovered in 10 months. In this case the bill had been running about $55,000 per year, and hence a 10 per cent saving was realized.

One customer with a $50,000 annual bill found that by raising his power factor from 75 to 90 per cent, he was able to save $4300 in a 13-month period.

These savings mentioned, due to the improvement in power factor, reflect only actual monitary savings in the electric bill. Since low power factor reduces wire capacity, an improvement in power factor enables present building wiring to take increased loads. In numerous cases where cables have been running hot, with low power factor, the plant has been able to delay indefinitely the installation of new wiring equipment merely by installing capacitors.

This résumé of methods of saving is not intended to cover all possibilities, but does outline most of the major ones. It is not expected that all of these approaches will be applicable in any one plant; in fact, that would be highly unlikely. Nor is it to be expected that everyone will be able to find some savings possible. The salient point is that for certain operating conditions, depending on the local rate provisions, savings may be realized.

Thus it is that a superintendent of power will find it worthwhile to get acquainted with a qualified representative of the local utility, who can help him review his power costs from time to time. THE END

Thermoelectric Modules Cool Electronic Equipment

FIRST LINE of commercially available thermoelectric cooling devices for industrial and military applications has been developed by Westinghouse Electric Corp.

Designed for use as electric component coolers and for other applications where compactness and silent operation require no moving parts and a controlled cooling rate, these "thermoelectric modules" come in a variety of shapes and sizes. The units can be simply mounted when used with transistors, diodes, and other electric components; moreover, they can be physically paralleled to cool a large flat area or stacked in series like building blocks for increased cooling.

For example, by proper orientation, a number of the modules could be constructed to form the walls of a "box," providing a compact space-cooler for electronic apparatus.

Rate at which heat can be removed from the cold surface of the module coolers depends on the temperature difference between the hot and cold surfaces of the cooler and on the power input to the unit.

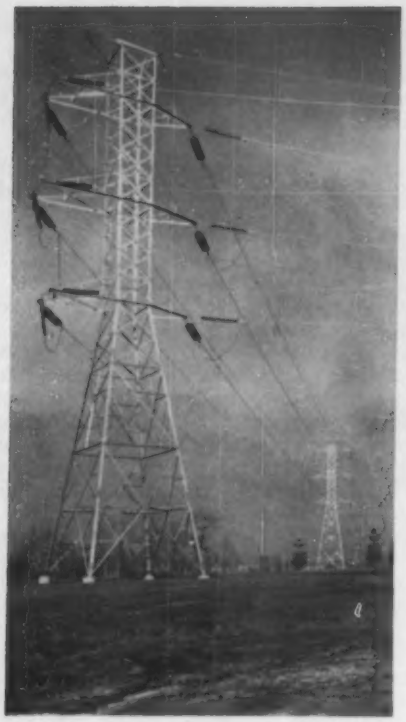
Heat Rejection Capacity

One type module can maintain a temperature differential of 25 C with a heat load of over 17 Btu per hr. Air or liquid cooling can be applied to the "hot" side of the thermoelectric cooler in order to supplement the heat rejection capacity of the module.

Exact amount and type of this cooling will affect the heat pumping capacity and ultimate temperature of the cold surface temperature of the module.

In general, the modules require power at high input currents and at low voltage. The current must be supplied from a d-c source or a filtered rectifier output.

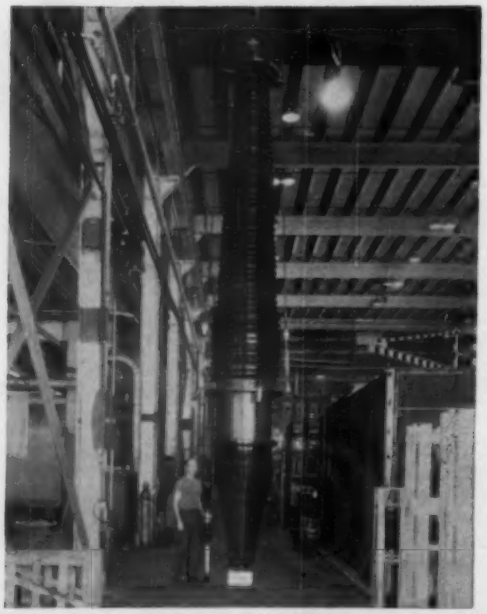
Unique modular construction of the new spot coolers permits a wide range of flexibility in application. This means, in many cases, that electronic equipment need not be redesigned to accommodate the devices. Equipment can be operated in higher ambient temperatures.



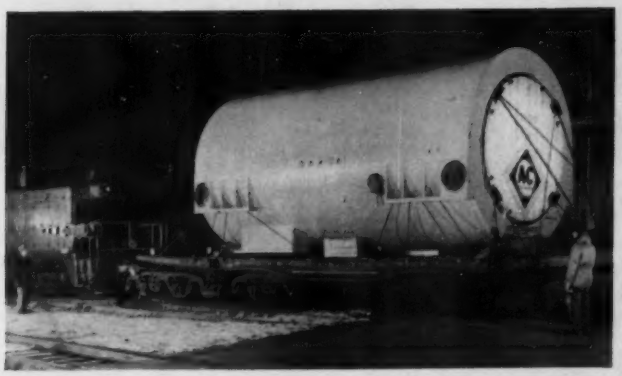
Eight aluminum towers, part of a group of 20 designed and built by Alcoa, comprise the initial mile of Philadelphia Electric Co's 6-mile 132-kv line from its Chichester substation to the new Eddystone generating station. Aluminum was specified by the company for this line on basis of cost

Runner for Fort Peck Dam in Montana shown being welded in Allis-Chalmers' shop on huge welding positioning table. Runner goes into one of two 63,500-hp, 128.6-rpm, 170-ft head hydraulic turbines

POWER ENGINEERING'S



Project EHV—GE's prototype transmission system near Pittsfield, Mass.—goes operational this summer, will begin testing at 460 kv, later using voltages as high as 750 kv. These two views are taken from final construction phases of the project. At left, workmen put bolts in place prior to lowering interrupter head into place on third unit of 115-kv air-blast circuit breaker installed in a substation. Shown above is a huge 650-kv bushing which will be mounted on a 40,000-kva power transformer. It weighs 10,000 lb, is probably highest-rated bushing ever built. Man standing next to it holds a 23-kv bushing

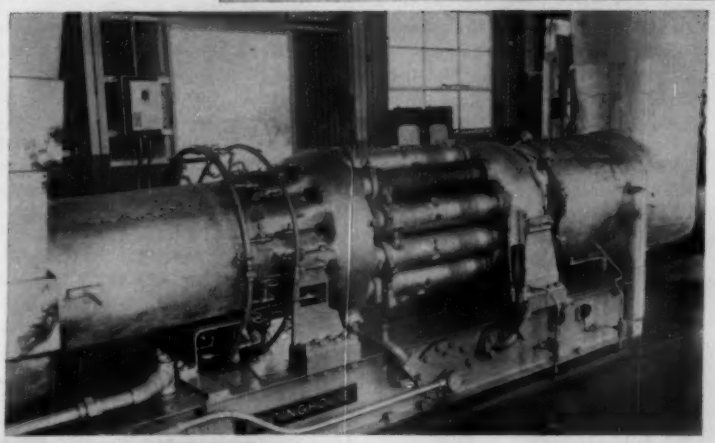


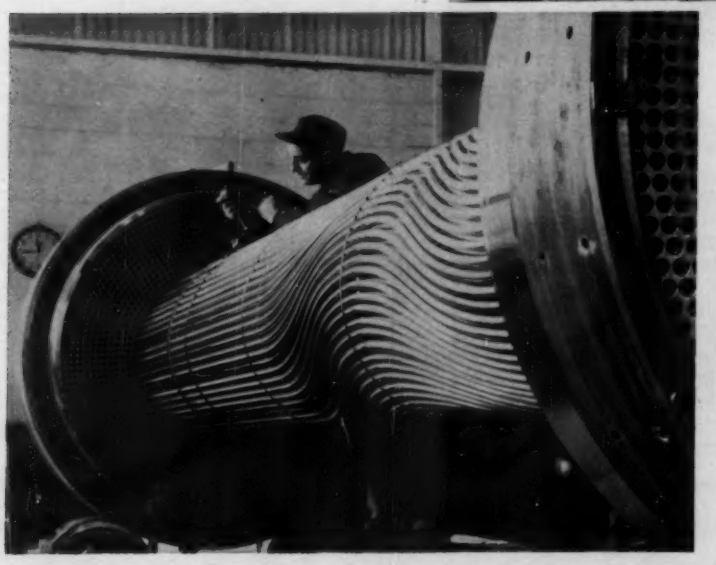
250-ton generator stator, heaviest single shipment ever made from Allis-Chalmers' West Allis Works, is bound for 220,000-kw unit in the T. H. Wharton station of Houston Lighting & Power Co

Sun-driven auto—a renovated 1912 Baker electric—is powered by a huge panel of more than 10,000 silicon solar cells mounted on roof. International Rectifier Corp manufactured panel

NEWS REEL

60,000 hours of operation have been logged by this 1800-hp gas turbine since May, 1949. Built by Westinghouse, the unit was first installed at Wilmar, Ark. Later it was moved to the Bonne Terre, Mo., compressor station of Mississippi River Fuel Corp





Sine curve stainless steel tubing being installed in heat exchanger for Enrico Fermi Atomic Power Plant. Sine curve, a compound curve required because of space limitations and flow direction in the exchanger, accommodates differences in thermal expansion in the tubing. Supplied by Allegheny Ludlum Steel, over 19 miles of steel tubing will snake through three intermediate sodium heat exchangers in the Fermi plant

Prefab Coal-Fired Boiler Wins Out in Navy Tests

Development program initiated by Bureau of Yards and Docks has demonstrated the feasibility of factory-fabricated boilers equipped for spreader-stoker firing of coal but readily adaptable to oil as an alternate fuel. This is true for capacities of from 10,000 lb/hr to 45,000 lb/hr

By LEROY F. DEMING*

LATE IN 1954, the Bureau of Yards and Docks began a program looking to the adaptation of coal-fired boilers to factory fabrication. The scope of the project was distributed to those of the boiler industry who had shown an interest in the Bureau's objectives, and each was invited to prepare tentative general arrangement sketches and guide specifications for the construction they would offer to meet the objective. All were invited to meet with the Bureau to discuss engineering and other aspects of the project.

Resulting interviews and studies indicated that for the lower capacities, the longitudinal drum design was the most economical type of construction, but for capacities corresponding to a drum length greater than about 22 ft, or nominally 25,000 to 30,000 lb per hour, economy dictated the use of the transverse drum type of design.

Obviously to accomplish the objective, prototype boilers of both the longitudinal and transverse drum design should be built and evaluated. However, for development the Bureau had funds for but one boiler of 30,000 lb per hour capacity.

At about this time there developed a requirement in the field for two 12,000-lb-per-hour coal-fired boilers. Funds were sufficient to permit a measure of development. There was a background of experience in Eastern Canada with one of the designs of boiler submitted in the 12,000-lb capacity range using spreader stokers and dumping grates.

While the installations cited involved field-erected boilers and stokers, it appeared logical that adaptation to factory fabrication did not involve any insurmountable obstacles, and so a contract was awarded for two 12,000-lb-per-hour factory-fabricated coal-fired boilers with factory-fabricated vibrating grate spreader stokers. Stoker fronts were to be interchangeable with oil burners. One boiler was to be assembled and tested in the factory, first with the oil burner and then the stoker, prior to shipment to and installation at an inland air station in one of our northwestern states.

With the lower capacity boiler of longitudinal drum design under contract, the Bureau then proceeded to negotiate a contract with one of the other boiler manufacturers to investigate the performance and adaptability of stokers that might be utilized in the factory-fabricated boiler and to report its findings to the Bureau.

This was followed by a contract to build a 30,000-lb-per-hour-capacity factory-fabricated coal-burning watertube boiler of transverse drum construction equipped with an oscillating-type mechanical ash discharge spreader stoker complete with combustion control. Boiler was to be equipped with oil burners for operation on oil when required.

Criteria for both boiler designs required only that conversion from one fuel to another must be capable of accomplishment over the average weekend, nominally 60 hours including cooling down and firing-up time.

Testing the Longitudinal Type

The longitudinal drum-type boiler is shown in Fig. 1. Briefly, this boiler was of the "A" type with the furnace completely enclosed between two convection banks of boiler tubes; a vibrating grate front discharge dual feed spreader stoker was separated from cinder hoppers at the rear by a bridge wall.

Combustion gases were carried first to the back of the furnace by over-fire air below the dual overthrow feeders. Gases returned along the furnace roof to the front where they entered the convection banks through openings in the baffles on each side of the furnace. Baffles in each bank were placed behind one row of 2-in. water wall tubes on 2½-in. centers which constituted the water-cooled walls of the furnace.

Three cinder reinjection hoppers were also fitted to the bottom of each sidewall and discharged the cinders back into the furnace crosswise of the

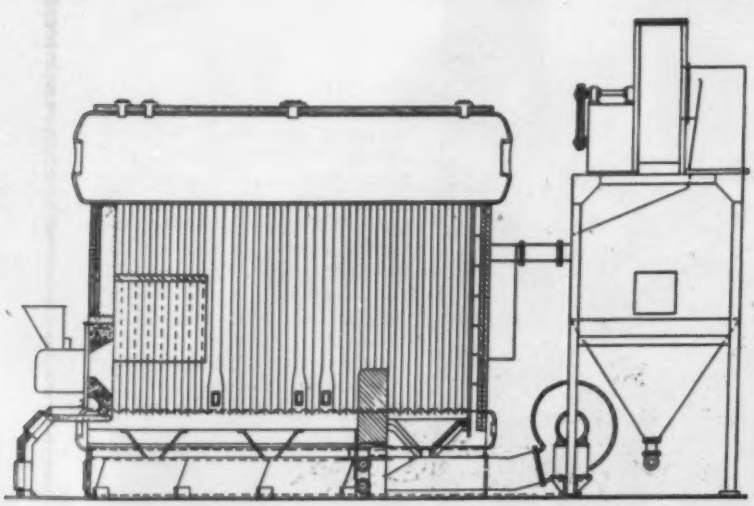


Fig. 1. Simplified cross section of 12,500-lb-per-hr Navy prototype boiler. Shipped to the field in six packages

*Manager, Power Generation Branch, U. S. Navy Dept, Bureau of Yards and Docks. This material is taken from a paper presented at the 1960 American Power Conference

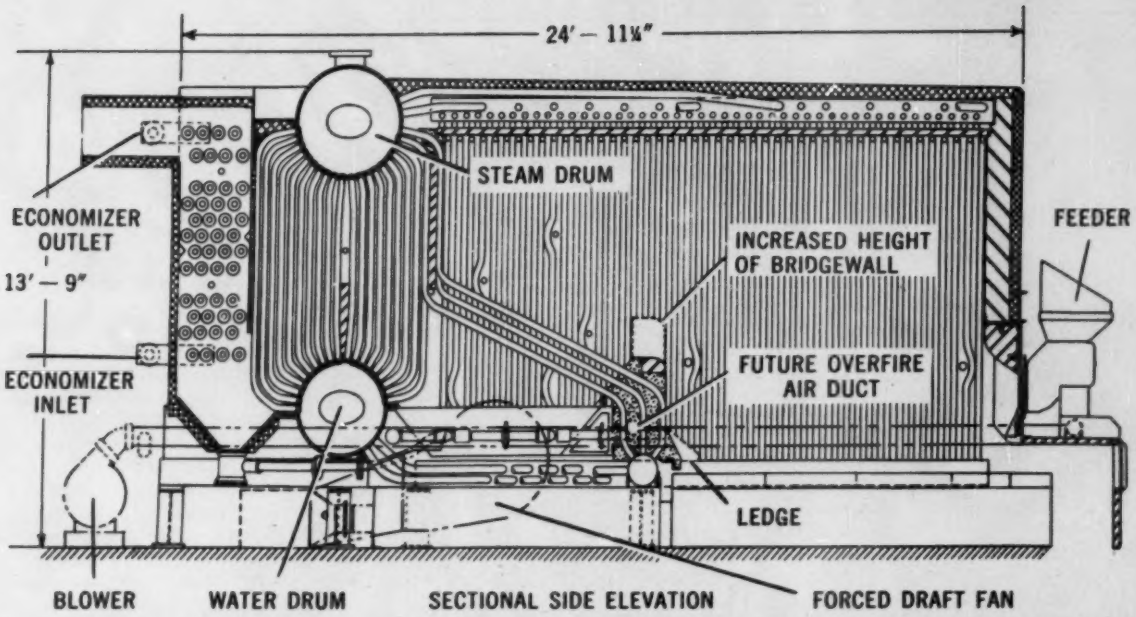


Fig. 2. Prototype stoker-fired transverse drum-type boiler, factory-fabricated, of 30,000-lb-per-hr capacity. Note modifications in bridgewall height and provision of slag ledge. Tested under three conditions of load, four different coals

grate. Cinder hoppers at the back of the furnace were fitted with two reinjection nozzles discharging through the bridge wall toward the front of the furnace. Induced-draft fan and low draft loss dust collector were fitted to the back of the boiler. Forced-draft fan at the rear discharged through the wind box under the stoker grates.

The two boilers of this type were each shipped to the field in six packages. No fuel oil pumping and heating set was included under this contract.

Tests† were all conducted on one boiler and, as it was determined that changes or adjustments were required, both boilers were brought to exact duplicate conditions. Coal used for the test was Gilson (deep seam) from the Knight Ideal No. 2 Mine, Carbon County, Utah, size 1½-in. × 0.

Tests indicated that the boiler, stoker, reinjection system, fans and all control units are capable of satisfactory operation from approximately 4000 lb per hour to approximately 14,000 lb per hour output.

Second, the unit and auxiliary tests showed the vibrating stoker capable of maintaining proper distribution and bed control throughout the load range represented by the tests.

Third, the efficiency test by the direct input-output method showed that the unit was capable of maintaining (and did for a period of eight hours maintain) an average rate of net steam output of 12,994 lb per hour at an average thermal efficiency of 85.31 per cent, an average hourly rate of heat release per cubic foot of furnace volume of 29,837 Btu, per sq ft of total boiler heating surface of 8428 Btu, and per sq ft of grate area of 383,000 Btu.

Testing Transverse Drum Boiler

Prototype unit for this type of boiler is shown in Fig. 2. This boiler was tested for the Navy by the contractor, Foster Wheeler Corp, under three conditions of load, recorded as Tests A, B, and C, while fired with No. 6 fuel oil and under a total of 13 different load conditions with four different coals, recorded as Tests D through P. (Coal characteristics are fully tabulated in the complete paper, but the table is omitted here.)

Boiler test data were recorded for both the direct input-output method and for the heat balance method. It was intended that the direct method data would govern, with the heat balance method indicating component performance. It was found, however, that the feedwater flow meter was erratic and hence the contractor's reported efficiency as developed by the heat balance method is not considered to be entirely conclusive.

Tests A, B, and C refer to operation on No. 6 fuel oil under load conditions reported as hourly steam generation rates of 11,092, 23,062 and 31,326 lb. Efficiency was reported by the indirect or heat balance method at 88.09, 87.96 and 85.13 per cent respectively.

It is reported that the combustible content of the dust collector accumulations following these tests was an indication that improper atomization was permitting droplets of oil to be carried through the unit and to be deposited as carbon in the dust collector.

Tests D, E, and F were conducted with coal from Ayrshire No. 2, Ind. Load conditions were reported as hourly steam generation rates of 11,044, 20,231 and 31,810 lb. Efficiency was reported by the indirect or heat balance method as 79.63, 82.71 and 81.57 per cent respectively.

Some difficulty was experienced with uneven air distribution and clinkers during Tests D and E. The slag ledge shown at the foot of the bridge wall formed during these tests and the condition was improved during Test F.

Stack emission was reported as one-half Ringelmann. Operation was reported very satisfactory after the slag ledge was formed. During Test F one observer reported cycling of steam output with grate oscillation, output increasing during oscillation.

Tests G, H, and I were conducted with Cal Strip sub-bituminous coal from Big Horn, Wyo. Load conditions were reported as hourly steam generation rates of 32,242, 21,484 and 11,310 lb. Efficiency was reported by the indirect heat balance method as 79.7, 81.05 and 78.71 per cent respectively. This coal was characterized by a much thinner, gas-like

†Those tests, and details of the boiler and its auxiliaries, were described in the article Stop Worrying About Fuel with the Week-End Convertible, POWER ENGINEERING, January 1956, page 72.

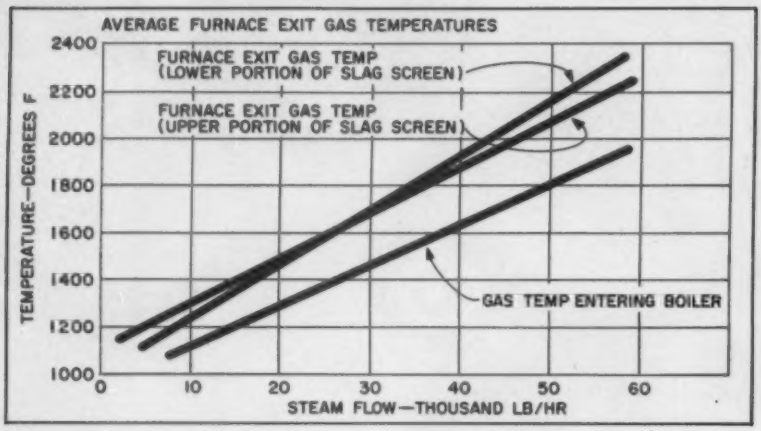


Fig. 3. Curves show that rate of heat absorption in the furnace was higher than design, which called for exit gas temp of 1820 F at 30,000-lb-per-hr load fired with "B" Kansas coal. Value was actually about 1670 F to 1720 F

flame. Performance was reported very satisfactory. Stack emission at all loads was reported as barely visible, estimated at ½ Ringelmann.

Tests J, L, K and P were conducted on high volatile "A" bituminous coal, Guyann, No. 5, W. Va. Load conditions were reported as hourly steam generation rates of 11,170, 19,884, 30,272 and 53,568 lb. Efficiency was reported by the indirect or heat balance method as 81.54, 84.85 and 82.59 per cent for Tests J, L and K respectively with no efficiency reported for Test P.

Conditions Reported

Good combustion and good fuel bed conditions were reported throughout these tests. Stack emission was reported 1 to 1.5 Ringelmann during Test J, 1.25 to 1.5 Ringelmann during Test L. Stack emission was reported satisfactory in Test K. Stack emission was reported as 2.9 Ringelmann during Test P and steam purity did not meet specifications; however, a very interesting maximum steam generating capability was demonstrated. Deficiencies can be corrected.

Tests M, N and O were conducted with Lancashire, No. 15, Penna low volatile bituminous coal. Load conditions were reported as hourly steam generation rates of 10,822, 20,550 and 29,309 lb. Efficiencies calculated by the indirect or heat balance method were reported as 80.17, 80 and 81.73 per cent respectively. This coal caused caking at the front of the grates. Inability to get balanced and controlled distribution of air through the grates was given as the cause of unsatisfactory operation, also the caking quality of the coal was a factor (Free Swelling Index No. 9).

Rapid load change tests were made for each coal as tested. With the coal used for Tests G, H and I it was possible to drop steam generation to 300 lb per hour meter indication, coal was burned down to where the grate was almost black, only a few red spots. Coal feed and air flow were then adjusted for one-third of rated capacity. Steam generation started to increase in three minutes and reached 14,000 lb/hr in 15 minutes.

With the West Virginia coal used in Tests J, L, K and P the load was dropped to the point where the steam integrator stopped, CO_2 in the stack gas was 1.0 per cent, and the fuel bed resembled a banked condition. Then coal feed and air flow were increased and in eight minutes steam generation had reached 36,000 lb per hour. The boiler demonstrated a continuous capability of approximately 42,000 lb/hr with furnace heat release of about 42,700 Btu per cu ft.

Experiment with the Pennsylvania coal also showed very quick response to load demand when the boiler is operating in a banked or minimum active condition.

Lignite Test

Following completion of the foregoing tests by the contractor, the Bureau of Mines conducted tests using lignite fuel. Load conditions were reported to be hourly steam generation rates of 11,110 and 27,740 lb. Duration of test was four hours at each load condition. Efficiencies calculated by the direct input-output method were reported as 75.6 and 67.2 per cent respectively.

Operational tests were conducted throughout the load range from 11,110 to 27,740 lb per hour. Performance of the unit and its auxiliaries as regards final gas exit temperature, fuel distribution, fuel bed ignition and the control of the fuel bed uniformity was found to be completely satisfactory over this range of load.

It should be further noted that the design of the boiler contemplated the temperature of the gas leaving the furnace at 1820 F at 30,000 lb per hour load when fired with high volatile "B" Kansas coal. Figure 3 indicates that this value actually approximated about 1670 F to 1720 F, indicating a higher rate of heat absorption than was contemplated.

These were the conclusions reached:

1. Boiler performance in each instance exceeded design expectations and indicates that greater furnace absorption rates are identified with the long horizontal furnace. Successful operation as demonstrated on the wide variety of coals also exceeded design expectations and indicates that factory fabrication does not in any way limit performance within capacities to which it is adaptable. The lower temperature of gases leaving the boiler indicates that increased limits on heat liberation are possible.

This condition is further confirmed by reports on two 35,000-lb-per-hour longitudinal drum D-type of factory-fabricated boilers installed by another manufacturer in Ohio. These were also equipped with mechanical ash discharge spreader stokers, but grates are of the reciprocating self-cleaning type, and the stoker was assembled in the field.

2. Factory-fabricated coal-fired boilers equipped with spreader stokers have been quoted to prospective purchasers within the last year for $3.33* per lb of generating capacity. This is for the boiler and stoker complete with all fittings, accessories, and automatic combustion control, in the general capacity range of 50,000 lb per hour, delivered in the Middle West.

3. Mechanical ash discharge spreader stokers, factory-fabricated, can be purchased for approximately 25 per cent above the cost of dumping grate spreader stokers or of the side dump single retort stokers. This makes possible full automation in the lower capacity coal-fired boilers, 10,000 lb per hour and upward.

4. Finally, the mechanical problem of fitting a factory-fabricated boiler and stoker together in the field has been found to be so encumbered with difficulties of clearance, fit and adjustment that it is recommended no one should normally expect satisfactory results unless at least the first units of any design are fully fitted together in the factory before shipment to the field. THE END

*Discussion following presentation of the paper indicated that this figure will shortly be reduced by approximately one-third.

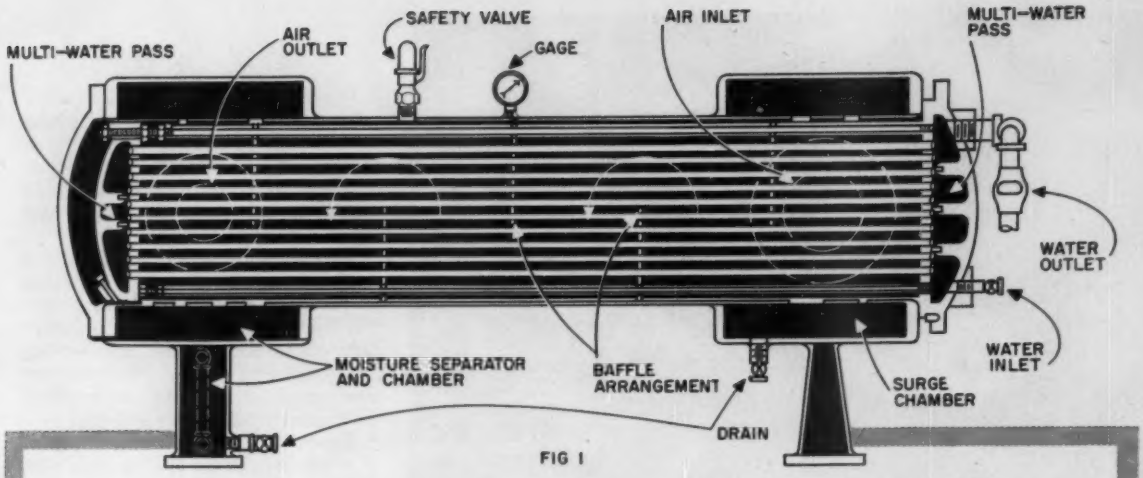


FIG 1

Air Compressor Accessories

An earlier article described the various types of compressors, and the drives used with them. Here is a listing of the various components used with compressors, and an explanation of their functions. All are very important in a complete compressed-air system

IN A COMPRESSED-AIR system, we find a variety of components, beginning with the compressor, and ending with the using-device (hand tool, air-powered machine tool, conveying system, etc). These components may be divided into three classes: those associated directly with the compressor, those in the line, and the items that are directly concerned with the working-tool or machine.

Chief among these components are the compressor silencer, intercooler and controls, line aftercooler, receiver, filter, dehumidifier, lubricator and regulator, and devices used to cool the using medium.

It is not necessary to have each of the above units integrated into every compressed-air system. Most systems have their own individual characteristics and requirements that dictate component needs. It will be our purpose, then, to examine each of these units to determine its function and use in the compressed-air system.

Heart of the compressed-air system is the *air compressor*, three of whose components deserve mention: the air-intake silencer, the intercooler, and the compressor controls.

Silencer

When the noise generated by either the suction at the compressor intake, or at the compressor discharge line, is objectionable, a silencer may be used. Care in selection should be used, however, so as not to lower the pressure by excessive resistance to normal air flow.

These units are sometimes combined with a filter to form a silencer-filter unit. They remove dust and other impurities before the air is drawn into the compressor, and muffle the air by directing the air flow through a series of baffles after it has been cleaned.

Depending on the characteristic of air to lose its ability to hold moisture when it is cooled, the intercooler is basically a heat exchanger — that is used to remove the heat of compression between the stages of a multistage air compressor. It therefore saves power by reducing, through cooling of the compressed air, the volume of air before it passes to the next stage of the multistage compressor. Cooling between stages also results in longer part-life and lower compression temperatures.

Intercoolers may be mounted in one of two ways: 1. completely piped at the factory (and mounted on the compressor); or 2. supplied without piping, for mounting away from the compressor.

The intercooler must be designed so as to make available the greatest possible temperature reduction between the low- and high-pressure cylinders of the compressor, with as little pressure drop as possible. Cold water, Fig. 1, flows through a nest of tubes that are in contact with the warmer, compressed air flowing around them. The direction of air flow is changed several times by baffles, to achieve maximum contact between warm and cold tubes. Precipitated moisture is separated and drained before the air passes to its next compression stage.

Compressor Control

Control of a compressor—whether it be by pressure, volume, or temperature — is accomplished by a change in capacity. Capacity control usu-

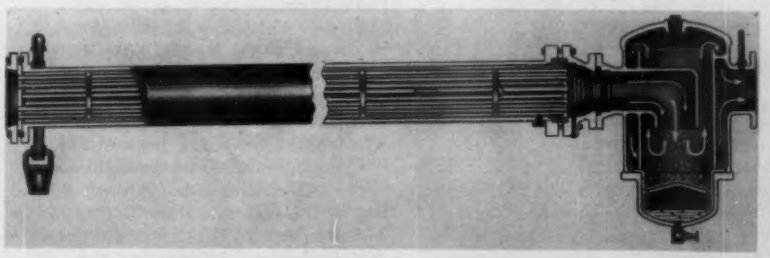


Fig. 2. Sketch of typical compressor aftercooler, as manufactured by Joy Mfg

Fig. 3. Air receiver acts as a reservoir and also as a cushion for compressed air

ally consists of a variation of two unloading means: inlet-valve unloading, or clearance control. Each system may be either manual or automatic.

Inlet-valve, or free-air, unloaders reduce compressor output by keeping inlet valves open. Thus, air (which would normally be compressed and discharged to the line) flows back through inlet passages. Unloading can vary from zero capacity (by unloading both ends of a cylinder) to one-half capacity, by unloading one end. This type of control may be of three kinds: inside operated (where the unloader is actuated by receiver air which holds a valve open), outside operated (where compressed air acts on an outside piston), and manual (where a mechanical device opens the valve).

Second means of capacity control is accomplished by increasing compressor cylinder clearance by the use of clearance pockets. The volume of these areas determines the amount of capacity reduction. By the use of pockets, air that is normally discharged to the line is compressed in the pocket areas, from which it expands to deliver energy to the compressor pistons.

Aftercooler

Like the intercooler, the aftercooler is also a heat exchanger. Its main purpose, however, is to cool the air *after* it is discharged from the compressor. It is a very effective means of removing moisture from air that has been compressed and heated. Compressed air usually contains a good deal of water vapor and, unless the water is removed soon after the compressed air leaves the compressor, will condense in distribution lines and enter tools and other air-operated devices or equipment. This results in increased maintenance costs and lower production.

A secondary, though important, function of the aftercooler is to remove oil that has been picked up by the air as it passes through the compressor. The aftercooler shown in Fig. 2 is designed to remove both water and oil from compressed air by condensing the water vapor and removing both this condensate and any oil that may be entrapped.

In performing its functions, the aftercooler can prevent wear in air tools, and other pneumatic devices, by preserving their lubricating oils, preventing corrosion and rust, combating rotting of air hose, preventing freezing in distribution lines, stopping valve clogging in sand-blasting equipment, and preventing contamination of agitation and pumping operations.

In the illustrated aftercooler, with inlet at the left and discharge at the right, primary separation occurs in the central compartment (velocity is reduced by about one-half and flow is reversed). Final separation is in the annular outer casing, with further velocity-reduction and flow reversals. Moisture and oil are trapped in the reservoir at the right, bottom Fig. 2.

Compressed air flows through many small tubes, with cooling water flowing in the opposite direction outside of the tubes. Baffles direct the flow of water to promote cooling; also, the tube nest is removable.

An air receiver is a tank that is used to store air after it is discharged from the compressor, and to dampen out pulsations in the discharge line. The receiver, therefore, guards against wasted power input and work that is not required.

An additional characteristic of the receiver, Fig. 3, is that it prevents undue wear on the compressor control system, by preventing unnecessary starts and stops. By receiving air at reduced velocity, the receiver also provides for the removal of condensed water vapor and oil.

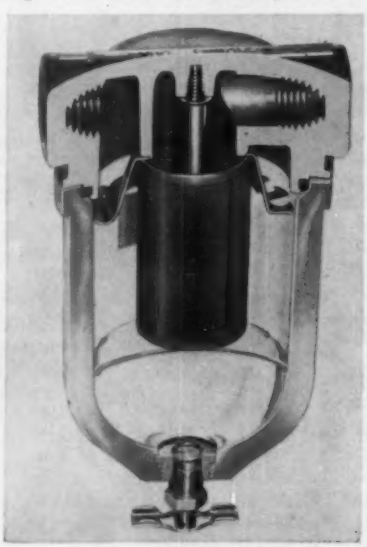
Receivers mounted in remote areas of a compressed-air distribution system serve as reservoirs, and insure against low pressure at point of use.

These units, used with a compressor and aftercooler, come in many sizes — varying from about 1 x 3 in., to 5 x 24 in.; and from 2 cu ft to 600 cu ft in volume — and with capacities of 20-8000 cfm at compressor operating pressures of 150-115 psi.

Filter

A filter is a unit that separates (and removes) dust and other contaminants (both solid and liquid) such as rust, spores, lint, grit, and deteriorated compressor oil from compressed air. It is said that each cubic inch of the air we breathe contains about one-half million contaminating particles. A typical 10-hp, 40-cfm compressor — providing some 70,000 cu in. of air — would therefore deliver almost 15 billion contaminants per minute. Obviously, action must be taken to prevent these irritants from damag-

Fig. 4. Cut of standard Norgren filter



ing pneumatic tools, cylinders, motors, and valves.

Filters of many kinds are available — including 5000-psi units that can screen out 40-micron particles. Also, metal screens for 75-micron particles, those featuring sintered-metal elements, and high-speed rotary units.

Figure 4 is a cutaway view of a drain-type filter. Units of this kind operate at 5 to 250 psi, in temperatures to 200 F, automatically collect and drain condensed fluid, and filter to the 25-micron size.

Air enters at the upper left through directional louvers and assumes a centrifugal pattern of flow that forces contaminants to the inside wall of the filter bowl. Liquids run down to the bowl bottom and are trapped by the curved baffle shown in the illustration so that they cannot re-enter the air-stream. Liquids and solids may be blown out of the bowl by opening the drain cock at the bottom. The air passes through the cylindrical filter element in the center before flowing out as clean air, upper right.

Dehumidifier

Depending on local conditions of humidity, temperature changes, the effectiveness of the aftercooler, and length of the pipeline, some water may be precipitated in the piping system. Some form of filter or drain must be provided at these precipitation points to get rid of the water before it can enter the distribution system. The dehumidifier serves this purpose.

When air is saturated with water vapor, water droplets form. This condensation point, known as the *dew-point*, varies with the temperature; the higher the temperature, the more moisture in the air before it is saturated. When air moves from the receiver along a pipeline, its temperature drops and water forms in the line — although the air is now saturated at a new, lower temperature. Finally, air reaches a pneumatic tool where the greatest cooling occurs. If the water has not been removed before it reaches this point, damage can occur in the form of corrosion, spray from a tool's exhaust, unnecessary tool maintenance, rust, or moistening of the work piece.

It may be necessary, then, to install individual water separators, or dehumidifiers, at places such as pipeline ends. These dehumidifiers may take one of several forms: a mechanical trap, regenerating units (removes moisture by adsorption), and replenished units (a dessicant in the form of pellets).

A special type of regenerating unit is shown in Fig. 6. This type, ideal for use with pneumatic instrument control systems, can dry air to dewpoints ranging down to −100 F, is automatic in operation, and independent of variations in air pressure

The assembly shown in Fig. 5 supplies clean, regulated, lubricated air to the line. Air flow is from left to right. It has four features: filter, lubricator, regulator, and drain trap. Contaminated air, lack of lubrication, and widely fluctuating pressures are enemies of pneumatic equipment.

Filter (top left) removes foreign matter such as moisture, scale, dirt, and dust from the air. The regulator (top center) is installed behind the filter in the air stream, and features high-flow capacity, response to demand changes, and self-bleeding to provide close regulation and to relieve pressure build-up in preventing pressure surges.

Lubricator (top right) introduces an oil-mist into the air stream to provide long life and reduced maintenance of pneumatic working devices. Air entering this section of the assembly flows through a venturi, where a small pressure drop occurs. This drop causes oil to rise through the feeder tube and be forced through a feeder — that passes the oil in the form of a fine mist to the line — and thence to a pneumatic tool. The drain trap (lower left) discharges accumulated moisture. It is an automatic unit, with copper tubing running to a service drain, and features a transparent reservoir, operation under varying or constant flow, and a discharge capacity of 18 gph at 90 psi.

Tool Cooler

If the cutting edges of tools are cooled, numerous benefits are realized. Among them are increase in cutting speeds, greater accuracy, finer surface finish, less power waste, increased production, longer tool life, and cleaner cuts.

A cooling device is used that is operated on air pressures of 80-150 psi. The container is filled with a cooling mixture, and a line is attached to a compressed-air source. The size and volume of the resulting spray may be regulated by needle valves; and the old methods of brushes, floor stands, tubing, and coolant pumps are eliminated. There is no air pressure on the container; a nozzle directs the coolant to the tool's cutting edge. The liquid coolant is atomized, and tool heat is dissipated, by the expanding compressed air. Chips are blown away. The unit uses

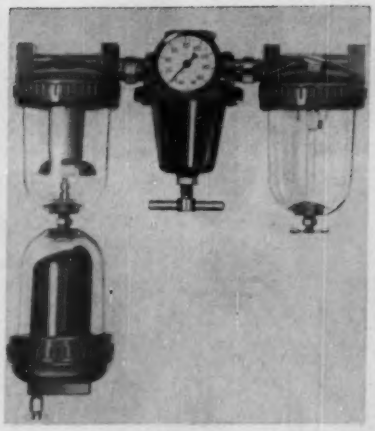


Fig. 5. Filter-lubricator-regulator-drain assembly, Hanna Engineering Works

only 0.04 cfm and is, of course, portable.

The components of the compressed-air system fall into three categories: those associated with the compressor itself, the units installed in the line between the compressor and the work, and those at the work.

Although every system may not require the wide variety of components available, each has a specific function and reason for being in a compressed-air system. · THE END

A handy guide to the use, maintenance, and functions of air compressors and their accessories is being prepared by POWER ENGINEERING as a reprint of a series which began in Sept, 1959, and will end next month. Single copies will be sent free to readers. Quantity lot prices will be quoted on request

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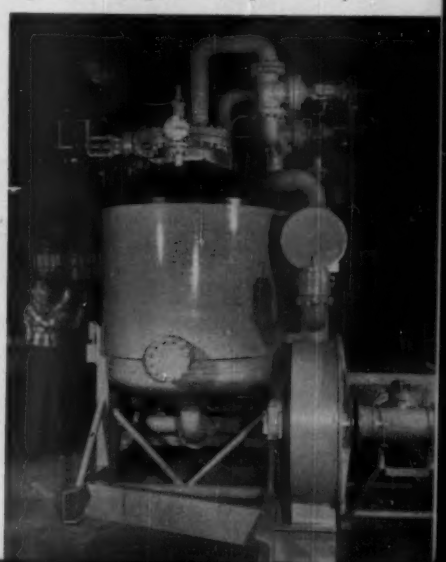
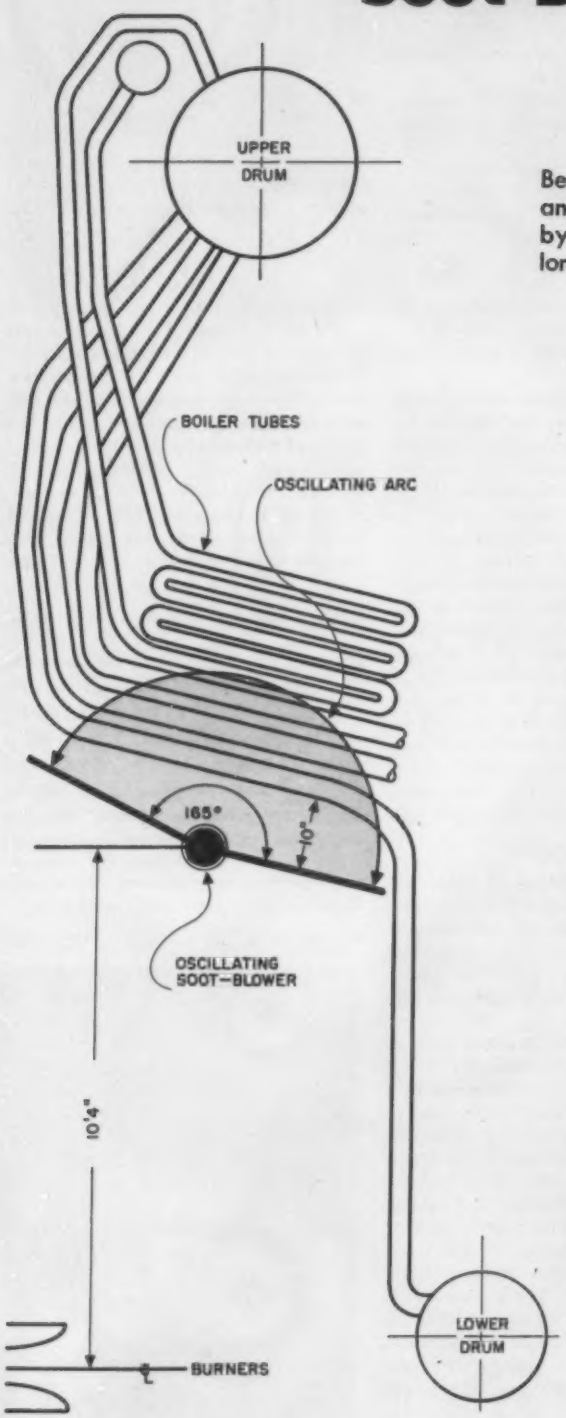
Fig. 6. Pittsburgh Lectrodryer air dryer



Here's a Unique Industrial Soot-Blower Installation

By **WILLIAM BOIS,** Power Engineer,
Hartford Fibres Co, Div of Bigelow-Sanford Carpet Co

Better boiler cleaning, an end to maintenance worries, and a halt of boiler outages have been accomplished by using a dual-motor drive to oscillate the lance of a long retractable soot blower at the Hartford Fibres Co



DUAL-MOTOR DRIVE permitted the lance of a long retractable soot blower to be oscillated, rather than rotated as in normal service. This was done to improve boiler cleaning, eliminate difficult maintenance problems, and avoid costly boiler outages at the Rocky Hill, Connecticut, plant of Hartford Fibres Company, a Division of Bigelow-Sanford Carpet Co.

The boiler, one of four, is a Combustion Engineering Type VU-10-16A fired with Bunker C oil. It delivers steam to the turbine throttle at 400 psig and 600 degrees F. Maximum continuous rating of this boiler is 40,000 pounds per hour, with peaks up to 47,000 pounds per hour. Except for annual inspection, operation is continuous with no seasonal variations in load.

As originally installed, a conventional rotary soot blower was used to clean the tube banks above the burners. This unit cleaned successfully for several years, but the element eventually burned out. At the same time, the hangers and bearings were also lost.

Danger of plugging the boiler with deposits made shutdown imperative. This meant overloading the other boilers, or finding another source of power, if normal plant production were to be maintained. It was found that removal and replacement of the burned-out material would be difficult, and would take more time than advisable to overload the other boilers.

After Study, a Decision Is Made

To avoid similar costly outages in the future, a study was made of other possible methods of cleaning this section of the boiler. The decision was made to replace the rotary soot blower with a long retractable type. This would eliminate hangers and bearings, and would assure the lance being outside the high-temperature zone except while blowing soot, at which time it would be cooled by the blowing medium passing through it.

A Vulcan T-25-E long retractable soot blower with dual-motor electric drive, made by Blaw-Knox Co, Copes-Vulcan Div, Erie, Penna, was installed about two feet below the tube bank, three feet six inches below the place where the original rotary unit had been mounted. This location was selected to minimize impingement of the blowing medium, which is steam with pressure reduced to about 100 psig, on the tubes.

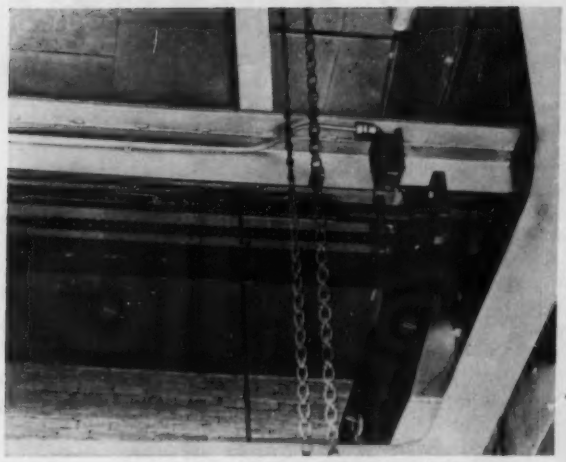


Fig. 1. The limit switch permitting oscillation is mounted on side of the long retractable soot blower

With the soot blower so much closer to the burners, it was obvious that normal 360-degree rotation of the lance could result in the flame being quenched by the blowing steam. The lance was, therefore, arranged not to rotate, but to oscillate 165 deg so that all blowing steam was directed upward against the surfaces to be cleaned, and none down toward the burners. Accomplishing this was primarily a matter of installing a limit switch in the power supply to the motor that would normally have rotated the lance. With a separate motor traversing the lance, oscillation had no effect on the speed with which the lance extended into the boiler and retracted from it.

Since 165-degree oscillation resulted in more concentrated and thus more effective use of the blowing steam, cleaning proved so effective that it has been necessary to blow soot only once every 24 hours. With the original rotary unit, soot had been blown on an average of once every shift.

After Two Years, Here Are the Results

After two years of cleaning with the oscillating long retract, a visual check at the time of an annual inspection showed no noticeable effect on tiles, baffles, or tubes. During this two-year period, the Vulcan soot blower had required only such routine maintenance as lubrication, and inspection of motors, wiring, and moving parts.

Selection of the long retractable soot blower raised one problem of erection. With the lance to travel approximately twelve feet, the aisle was no more than six feet wide. Therefore, a hole was made in the building wall to permit about half of the soot blower to protrude outside.

The steam valves and motors are thus exposed to the elements where year-round ambient temperatures range from −10 to 94 deg F. The weather conditions have had no adverse effect on soot blower operation. The only precaution taken is to drain the steam supply line after blowing soot. THE END

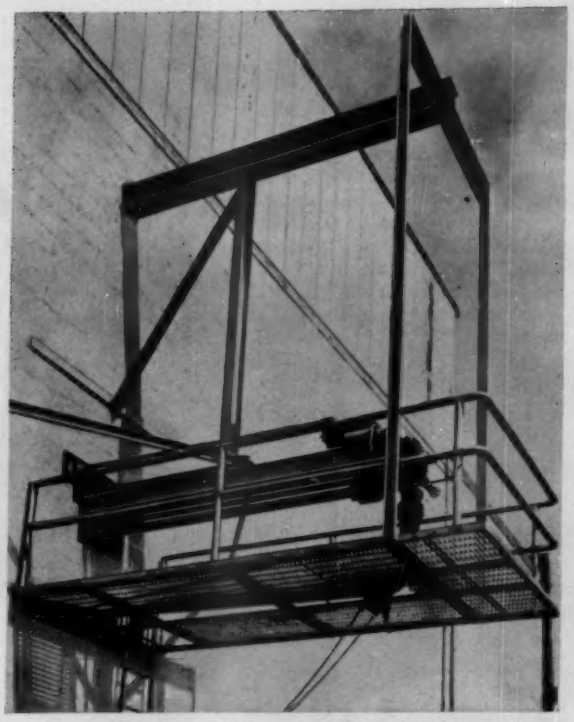
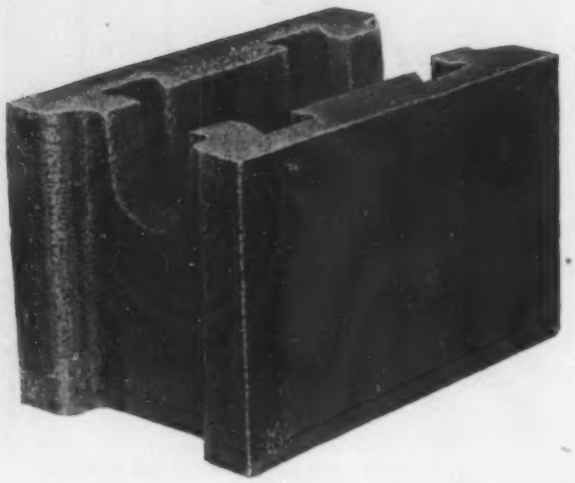


Fig. 2. The steam valve and both of the motors of the long retractable soot blower are outdoors and are unprotected against changing weather conditions. The chain-operated valve permits the draining of steam from the line after the soot has been blown

Fig. 3. The multi-helix cleaning pattern, which is inherent in dual-motor drive, is shown by markings on feed pipe. Oscillation intensifies this pattern

New Refractory Cuts Furnace Lining Time



Now a new product ends spalling in walls and arches, gives a greater insulating value than firebrick. Furnace Blok makes possible good quality, truly monolithic refractory construction —without using wooden frames of any type

Fig. 1. This is Furnace Blok

IN BOILERS and ash hoppers, the ideal refractory wall would be erosion and spall resistant, have high insulating value, and not be susceptible to slag build-up. From the standpoint of installation, it would be erected rapidly, thereby keeping expensive down-time to an absolute minimum.

While ordinary and special types of fireclay firebrick have always been used for boiler and ash hopper walls, their disadvantages are widely recognized, yet accepted. Brick has a very long history as a refractory building unit, and if it has one major advantage, it is that of being the first, and the accepted refractory commodity for many years.

Firebrick construction is very far from ideal. Its numerous joints and resultant uneven expansion and contraction characteristics make it subject to spalling. Its inherent porosity as well as its joints provide considerable "key" for slag build-up. Laying brick requires many man-hours of highly skilled labor.

A poured, monolithic, or jointless construction would, in most cases, have vastly superior properties. However, labor required for the complicated wooden forms is so expensive that monolithic walls and arches are often not considered due to initial expense. It is agreed, nevertheless, that monolithic construction almost always provides a more durable and maintenance-free wall.

A new product called Furnace Blok makes it possible to produce good quality, truly monolithic refractory construction without using wooden forms of any kind.

Walls and arches made by the Furnace Blok method are not susceptible to spalling. Their insulating value is superior to that of the better grades of firebrick. They have lower heat storage, and they usually weigh less than firebrick walls of equal thermal properties. And, very important, for nearly all applications where firebrick is used, Furnace Blok can be installed from 3 to 10 times faster using inexperienced labor.

What Is Furnace Blok?

Furnace Blok is a patented, specially designed, pre-formed, hollow refractory unit manufactured by the Refractory & Insulation Corp of New York, N. Y. The larger size Blok, 9 in. high x 13½ in. wide x 13½ in. thick, equals the volume of sixteen 9-in. x 4½-in. x 2½-in. firebricks. The small Furnace Blok is 9 x 13½ x 9 in. and equals the volume of eleven firebricks.

To construct a monolithic Furnace Blok wall, the individual Blok units are placed end to end in normal pattern. After five courses have been placed, the Bloks are filled, by bucket or gun, from the openings in the top course. The fill consists of high quality pour-type refractory which flows smoothly down and to the right and left, completely occupying the hollow portion of the structure. The second five courses are then placed and filled as before. This is repeated until the desired height is obtained.

Since the fill refractory and the Furnace Blok units are nearly identical in composition and properties, once the fill has set, the structure is unified and is monolithic in nature.

To satisfy various hot face temperature requirements, there are available 12 different types of Furnace Blok and accompanying fill refractories. Fill refractories are supplied dry in bags and must be mixed with water before use. Fill refractories are shipped together with the Furnace Blok.

The *material* cost per square foot of a Furnace Blok wall is approximately the same as that of a firebrick structure of equal thermal properties. However, in many cases where Furnace Blok replaced firebrick, the installation time and labor required for the former was so much less as to be almost beyond comparison.

Even without witnessing an actual

demonstration, one can visualize the savings which result when eleven or sixteen brick equivalents (one Furnace Blok) are installed in little more than the time necessary to lay and bond 2 or 3 firebricks. Furnace Blok units are easy to handle and transport. There are no exacting or skilled operations required in installing. Yet Furnace Blok can be placed with proper accuracy to insure that the final structure meets dimension specifications.

While the appreciable saving in installation time and labor is a major advantage of Furnace Blok, the product's record of performance has also been outstanding. It has shown itself to be superior to previously used firebrick in every case in which a comparison was possible.

Used for rebuilding an ash hopper wall at an East Coast utility, Furnace Blok, at the end of a year's service, was still in satisfactory condition even though there was some erosion of the surface. Salt water is used at this station to quench the ashes, and it is possible that this might have a more deleterious effect upon refractories than fresh water. The lining previously used in the ash hopper had to be replaced at the end of six months.

One of the most revealing service reports on Furnace Blok comes from the Colfax Station of the Duquesne Light Co, Springdale, Penna.

Application and Result

A stoker wall, 34 ft long x 18 ft high, of a powdered-bituminous-coal boiler was rebuilt with Furnace Blok at a saving of nearly 50 per cent in labor. First quality firebrick had been used before. The actual Furnace Blok wall consisted of Type 2900 Blok (13½ in. thick) backed by 2½ in. of Castabloc insulation. The total 14-in.-thick wall provided the same thermal efficiency as did the previous brick wall of 22 in. mean thickness. Stainless steel (304) anchors on 27-in. x 13½-in. centers were used.

An inspection after 14 months showed the wall to be in excellent condition. Slag build-up, a serious problem with the previous structure, was practically nil.

A firebrick wall, placed into service at the same time in another similar boiler at the station, showed the effects of heavy slag build-up. The weight of the slag had broken off the faces of the firebrick, and considerable repair to the wall was necessary.

It was further reported that by increasing the thickness of Castabloc a relatively small amount, the resulting higher thermal efficiency of the structure would effect a marked Btu saving.

This being so, the advantages of Furnace Blok construction are worthy of consideration on the basis of fuel economy as well as installation, durability, and low maintenance — the factors which have so far been responsible for the ever-increasing applications of the product in the power industry.

For more information about this new product, write the Editor, or jot down "Furnace Blok" on our enclosed post card. THE END

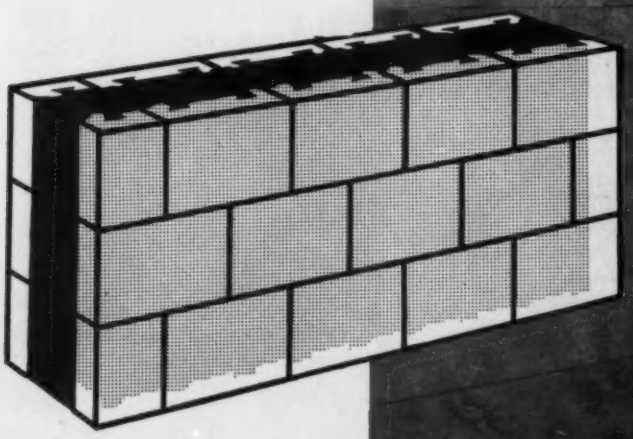


Fig. 2. Detailed drawing of Furnace Blok pattern of five courses each. Dark black area shows where Blok is filled from the openings in the top. Fill occupies the structure's entire hollow area

Fig. 3. Workman uses a gun to inject the fill into five courses of Furnace Blok wall. High quality pour-type refractory flows smoothly, fills up the Blok

Burning Anthracite for Better Efficiency and Smoke Abatement

By NORMAN C. CURTIN*

Conversion to admixtures of bituminous coal and anthracite or to bituminous and straight anthracite No. 1 Bk in underfeed dead-plate stokers is a simple procedure. Discussed are methods which can lead to better plant efficiency and to the abatement of smoke

IT IS A FACT that under proper conditions all fuels can be burned smokelessly; it is also a fact that the tendency to pollute the air is directly related to the content of heavy hydrocarbons and sulfur.

As heating and power plant efficiency increase by eliminating the causes of smoke, then the terms smoke abatement and boiler efficiency become synonymous.

Anthracite, which has no heavy hydrocarbons and is very low in sulfur content, is the only inherently smokeless fuel, and coke, which is a by-product of bituminous coal, is also recognized as being a smokeless fuel.

Adequate combustion space is vital for efficient combustion of heavier oils or bituminous coal as heavy hydrocarbons are released in large volume at low temperatures; and ample clearance height is a *must* if smoke is to be abated.

Inadequate combustion space is one of the causes for soot deposit, which retards heat transfer in addition to creating losses in the combustion process. This fact is indicated by U. S. Bureau of Mines report 3272, as shown in Table I.

Further proof of loss due to soot in cast iron boilers was cited by Dr. Harold J. Rose in his paper before the 1939 Lehigh University Conference. Dr. Rose showed that cast iron boilers burning bituminous coal emitted 20 per cent black smoke for an average of 7 hours in 24. He also showed that the bottom section, when burning highly volatile bituminous, had a deposit of soot up to 1¼ in. thickness, while low volatile bituminous deposits reached a thickness of ¾ in.

It is practical to abate or eliminate smoke from plants where underfeed dead-plate bituminous coal stokers are installed in boilers with vertical clearance less than what is shown in Table I.

While conversion of this type of stoker from bituminous coal to an admixture of anthracite or to straight anthracite is a very simple procedure, there is still considerable adverse criticism to conversion simply due to lack of knowledge of some simple fundamentals of combustion.

The fact most commonly overlooked is that a worm or plunger conveyor feeds volume, not weight. It would feed the same volume of lead shot as puffed rice, yet there is a vast difference in weights. Similarly, a conveyor at a given speed would feed almost twice as much weight of carbon as with bituminous coal, and the available amount of air would be insufficient, thereby causing severe clinkering.

Stoker Conversions

The detailed instructions in Table II have proved very helpful in obtaining satisfaction with conversion of bituminous coal dead-plate stokers to admixtures of anthracite or to straight anthracite, for eliminating smoke emission.

While preliminary mixing is advantageous, a thorough or intimate mix is not a must because mixing occurs as coal flows in a crater-shaped stream from the top of the stoker hopper down to the worm conveyor; thus the action is similar to cutting through cake layers.

Any clinker difficulty from an admixture of anthracite and bituminous coals in dead-plate underfeed stokers can be eliminated in most cases (see Table II).

In many instances, satisfactory results have been obtained by making only minor changes in coal feed and draft control — with no cost involved. Any bituminous coal on hand can be admixed in small quantities with anthracite buckwheat in converting to straight anthracite No. 1 Bk. The steps to follow are shown in Table II also.

No difficulty is generally experienced with carrying the required load by using the "trough method," as described in Table II. However, if difficulty should exist, then the dead-plates should be converted into active grate area. Since there is a wide variation in types and design of dead-plate stokers, the method of providing additional grate area and air control will also vary.

*Engineer, Anthracite Information Bureau

Table I. Listed are firebox heights of compact, locomotive firebox, HRT, and cast iron boilers. Also shown are comparisons of efficiency losses from soot thickness

	Firebox Height (inches)			
B.H.P.	10–18	51–80	101–125	151–175
Compact Type	36	48	60	72
Loco. Type	48	60	72	84
H.R.T. Type	—	48	60	72
Cast Iron	36	48	60	—

Note: All dimensions are from stoker dead-plate or dump grate to the crown sheet or equivalent. On down-draft boilers, the water grates shall be considered equivalent to the crown sheet. The above figures are considered to be minimum dimensions and shall be increased when over-loaded.

Soot Loss—Transfer of Heat Through Iron Plate				
Thickness of soot in inches	1/32	1/16	1/8	3/16
Loss in efficiency, per cent	9.5	26	45	69

Note: U. S. Bureau of Mines cites that test boiler had three intermediate sections and that only 14% of total heat transfer was affected by this deposit; hence 50% loss in heat transfer is actually only 7% of the total. This does not include waste due to incomplete combustion caused by poor draft from clogged flues. Insufficient draft can cause losses up to 25% or more.

It is advisable to replace dead-plates (space surrounding the retort) with a series of small cast iron grates, when the dead-plates consist of refractory material or cast iron plates are too heavy to make drilling practical. By admitting air through these grates, the area of the fire bed is increased so that straight anthracite can be burned at a combustion rate to generate the amount of heat for which the stoker was designed.

It is often possible to drill dead-plates without removal from the boiler when they consist of castings suitable for drilling. If the stoker design provides for an air duct integral with the retort, then it becomes necessary to cut openings in the duct to supply air under the grates.

Generally, where castings are provided for dead-plates, the air duct extends through the boiler front wall, and the entire area below the retort and plates serves as one plenum chamber, thus supplying the same air pressure for the grates replacing dead-plates.

Important Controls

Particularly, for stokers without volumetric air control, it is important that the flap damper in the air supply duct be blocked wide open so that some natural draft is supplied through the blower when it is idle. Furthermore, it is important to install a control on the inlet to the fan and remove or open one if it exists on the fan discharge or air duct.

A simple control on the fan or blower inlet can be made of two thin metal plates of a size to cover the fan inlet when closed and to open in the shape of an inverted V by means of bolting the top center. This bolting serves as a pivot or hinge where the plates join to the fan inlet casting. A volume of air is thus supplied without the undesirable velocity that could cause uneven air distribution within the fire bed.

Smoke is completely eliminated by either of these changes, and no investment is necessary. Drilling can be done with the grates in place. Bituminous coal on hand can be mixed with anthracite until it is consumed.

Where stokers are equipped with volumetric air control, it has been found good practice to place a ¼-in. or ⅜-in. stove bolt under the air duct flap damper so that some air is continuously admitted to the retort. Such alterations provide excellent plant performance with no smoke emission. THE END

Table II

Conversion of Bituminous Coal Dead-Plate Stokers to Admixtures of Anthracite

1. **Reduce Coal Feed Rate.** Reason: Stoker or worm feeds a constant volume for each fixed operating speed. Since more weight per unit volume is fed when anthracite is added, coal feed rate must be reduced.

2. **Loosen the Fuel Bed.** Reason: When admixture is first started, the anthracite tends to push up through the center due to the resistance of the coke formation along sides of the retort. Unless fuel bed is loosened by slicing the coke free, air distribution will not be uniform. After fire bed becomes uniform, no further stirring is necessary.

3. **Prop the Flap Damper in the Air Supply Duct so That It Remains Open After Stoker Stops.** Reason: A continuous supply of air by natural draft through the fan will maintain an oxidizing atmosphere. No overheating should occur, and stoker is ready for quick heat demand.

4. **Regulate Stoker Cycle to Long "On" and Short "Off" Periods.** Reason: A more nearly uniform combustion rate decreases tendency to clinker, reduces stack temperature, and increases the efficiency.

5. **Use Anthracite Size Which Will Burn Out at Same Rate as the Bituminous Coal in the Admixture.** Example: Rice, barley, or anthracite screenings with bituminous nut/slack; No. 1 Buckwheat with stoker pea or nut double-screened bituminous coals. Reason: Air supply will be shut off in the area of incandescent partially-burned anthracite if surrounding particles of bituminous coal have burned completely to ash.

When removing clinkered ash, it is imperative that only the large clinker is removed. Allow the fine ash to remain in a sloped position from the lower end of the tuyeres up to the side of the boiler, thus forming a trough in which air distribution is satisfactory. There need be no fear when making the trial as it is possible to return temporarily to straight bituminous coal if necessary.

Conversion of Bituminous Coal Dead-Plate Stokers to Admixtures of Straight Anthracite No. 1 Bk

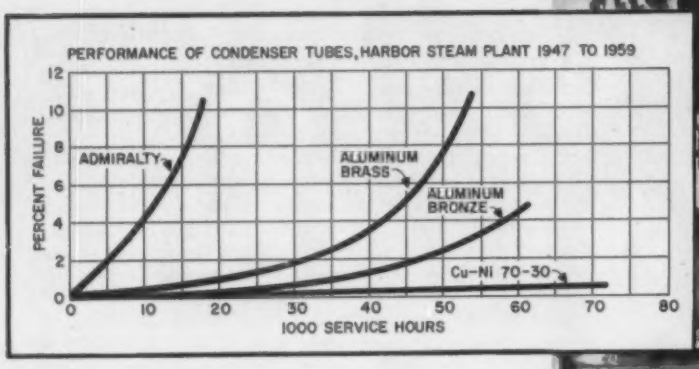
1. **Reduce Coal Feed Rate.** Reason: Stoker or worm feeds a constant volume for each fixed operating speed. Since more weight per unit volume is fed when anthracite is added, coal feed rate must be reduced.

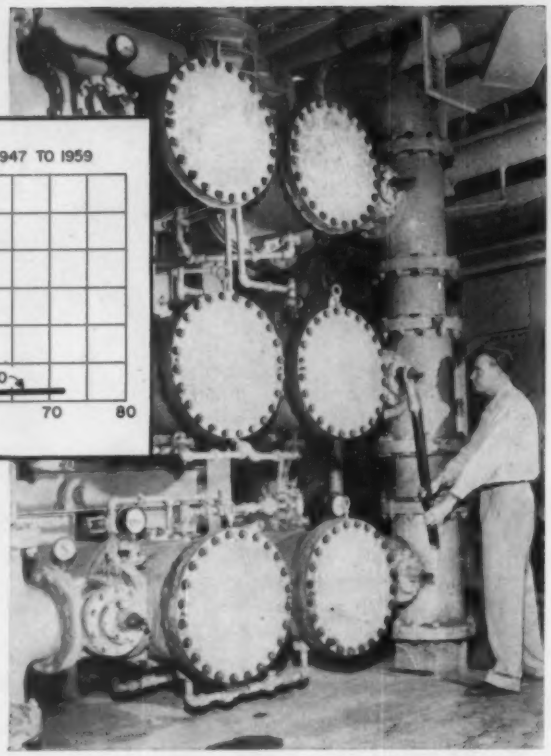
2. **Prop the Flap Damper in the Air Supply Duct so That It Remains Open After the Stoker Stops.** Reason: A continuous supply of air by natural draft through the fan will maintain an oxidizing atmosphere. No overheating should occur, and therefore stoker is ready for quick heat demand.

3. **While starting test run, it may be necessary to "wing" or scrape partially-burned coal from the dead-plates to above the tuyeres (airholes.)** However, this will not be necessary after fire bed has once been cleaned as suggested in step 5.

4. **Regulate Stoker Cycle to Long "On" and Short "Off" Periods.** Reason: A more nearly uniform combustion rate decreases tendency to clinker, reduces stack temperature, and increases efficiency.

5. **When cleaning fire bed, it is important that only the large clinker is removed.** Allow fine ash to remain in a sloped position from lower end of the tuyeres up to the side of the boiler, thus forming a trough in which air distribution is satisfactory. Never clean the dead-plates completely.





Harbor Plant Study Solves Condenser Tube Problem

By H. A. TODHUNTER *

Fig. 1. Graph (left) shows performance and percentage of failures of condenser tubes used at Harbor Steam Plant from 1947–59. Fig. 2. Six heat exchangers were modernized with 70–30 cupro-nickel tubes

CONDENSER TUBE failure at the City of Los Angeles' Harbor Steam Plant during the years 1944–1945 became so severe that a special Condenser Tube Research Committee was formed to study the acute problem. During these years aluminum brass tubes in sea water surface condensers were failing after approximately one year's service.

Cause of the problem, the committee soon found, was the presence of anerobic bacteria and dissolved hydrogen sulfide in the cooling water. Analysis of the water in the busy inner Los Angeles harbor showed little or no oxygen content and the presence of oil refinery waste, oil, fish cannery refuse, and other forms of pollution.

Anerobic bacteria living in these conditions excreted a substance containing hydrogen sulfide, either into the water or directly onto the tube wall. Examination of the failing tubes showed large amounts of black porous scale on the tube wall; this turned out to be largely copper sulfide.

To solve this problem, the research committee began a systematic program of tube testing and simultaneously asked governmental agencies in the area to assist in controlling the pollution. As a result of the anti-pollution campaign, the amount of dissolved hydrogen sulfide in the cooling water dropped sharply.

Meanwhile, an extensive tube research program was put into operation which included nearly every type of condenser tube manufactured for severe conditions. Fifteen hundred and sixty-six tubes of different types were installed in two test condensers in 1947. Admiralty metal (without inhibitor, and with arsenic, antimony and phosphorus inhibitors), aluminum brass with the same inhibitors, aluminum bronze, 70–30 cupro-nickel, and 90–10 cupro-nickel were put on trial in the two test condensers.

Results of Tests

Tests continued for three years, and as a result the Harbor Steam Station in 1950 standardized on 18-ga 70–30 cupro-nickel condenser tubes with 0.4 to 0.8 per cent iron content. Iron content was found to be critical in controlling the corrosion problem. Raising or lowering of this content adversely affected the life of the tubes. Tests on tubes of the above copper-nickel-iron composition showed appreciably less pitting. After 30,000 hours of testing, pits were less than 0.005-in. deep.

Routine retubing of the ten half-size condensers at the Harbor Steam Plant began in 1950 after the tests were concluded, and proceeded as the old tubes required replacement. The station has five generating units. Six of the condensers have 35,000 sq ft of cooling surface each, are two-pass, and have 5878 tubes each. The remaining four condensers have 30,000 sq ft surface with 5040 tubes. Tubes are 26-ft 3-in. long, and $\frac{7}{8}$-in. O.D.

Since installation in 1950, the 70–30 cupro-nickel tubes have been giving excellent service. In all there are 40,000 of these tubes in use and many have had 50,000 hours' service.

Water velocity at Harbor Steam is now 7 to 7½ ft per sec with about 300,000 gpm flow. Cooling water temperature range is 58 to 72 F. Design turbine back pressure is 1½ in.

Standardization by Harbor Steam Plant on 70–30 cupro-nickel tubes has helped solve a critical problem and furthermore has resulted in substantial savings. THE END

* Los Angeles Dept of Water and Power

Robert A. Taft Sanitary Engineering Center on the Ohio at Cincinnati is run by the U. S. Public Health Service for research and training in pollution control for water, air, radioactivity, food. One- or two-week courses, tuition free, are open to engineers needing instruction in new techniques for handling water quality and other problems

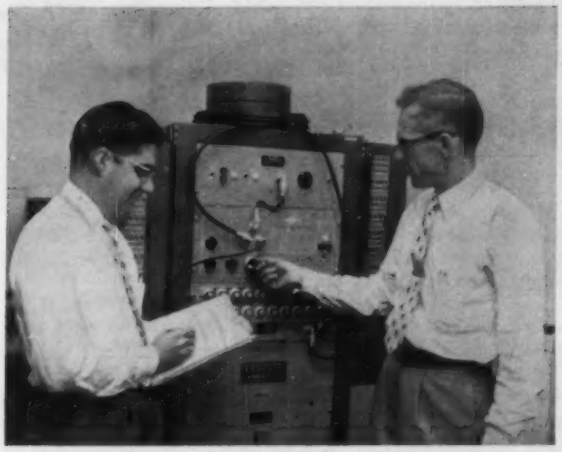


Fig. 1. Two engineers from Dresden Nuclear Power Station complete a course in radiological health at Taft Center

Fig. 2. Center's course in aquatic biology for engineers deals with stream organisms that interfere with plant equipment

Taft Trains for Pollution Control

TECHNOLOGICAL developments in industry are placing increasing demands upon man and his environment. For example, wastes arising from these newer operations include radioactive materials from the nuclear power industry, complex organics from the chemical industry, and a multitude of other liquid, gaseous, or solid water-borne and airborne substances. Even heat itself from power plant operations is termed "thermal pollution" of streams.

Management of such wastes is not easy, often demanding still other technological developments. Solutions to many of these problems are being sought and found through coöperative effort by the Public Health Service's Robert A. Taft Sanitary Engineering Center at Cincinnati and industrial, university, and other research groups.

To bring pollution control developments rapidly to the attention of industry, state and local health departments, and air and water pollution control agencies — which put them into practice — the Center conducts an extensive training program. Since July, 1952, more than 4000 persons have attended short-term technical courses presented at the Center. More than 500 of these trainees were from industry; and in certain specialized courses, industrial participants made up over 50 per cent of the enrollment.

Scope of Program

The scope of this training program ranges widely over the environmental health problems of industrial technology. Chemists and engineers are offered detailed laboratory practice in specific techniques for analysis of harmful wastes, as well as executive training in the technical administrative aspects of pollution control. This training pays dividends in operational savings, as has been demonstrated repeatedly.

Such a coöperative program is by no means a one-way street. Often incipient problems are brought to the Center staff, thus leading to an earlier search for solutions. The Center makes every effort to utilize recent technological advances won by industry, and prominent experts from industry are called in as special consultants and lecturers on the faculty. Members of the Center staff often have coöperated with industry in the development of new equipment, as for example, the development of dissolved-oxygen analyzers.

The training program at the Center offers intensive courses of one or two weeks in subjects of all four research areas under investigation at the Center: 1. water supply and pollution control; 2. air pollution; 3. milk and food; and 4. radiological health. The following should be of special interest to power engineers:

Reactor Environmental Health Problems: This course provides an introduction to the over-all health and safety aspects of nuclear reactor operations, including features of the reactor itself, the reprocessing of spent fuels, disposition of wastes, and other supporting activities. The final

portion of the course is conducted at the Oak Ridge National Laboratory, where trainees engage in a three-day working tour with actual operating reactors.

Water Quality Management: This course is offered for personnel with responsibilities in the administration of water quality management programs. Various types of wastes, including those of significant heat content, are considered from the standpoint of their effect on the quality of receiving waters, the appropriate parameters for the measurement of such effects, and the steps to be taken in reducing them.

A mock water pollution hearing provides practice in the adjudication of water uses as a stream flows from municipality to municipality, in terms of the new Federal Water Pollution Act.

Industrial personnel have found this course most helpful in determining what parameters are of greatest significance in the evaluation of water quality for industrial use.

Air Pollution Control: Two one-week courses are offered dealing with the control of particulate and gaseous emissions, respectively. These courses are designed for air pollution control officials and other professional persons in the field of air pollution. Applicability and performance of various types of control equipment, the engineering aspects of control procedure, and the use of natural facilities are stressed.

No tuition fees are charged, the only costs involved being transportation and subsistence. In all, over 40 different courses are being offered. Complete information on these and the schedule for coming months may be obtained by writing to Harry P. Kramer, Chief, Training Program, Robert A. Taft Sanitary Engineering Center, 4676 Columbia Parkway, Cincinnati 26, Ohio. THE END

CO_2: A Villain Laid Low by Filming Amine

By B. Q. WELDER*

CARBON DIOXIDE is one of those Jekyll and Hyde substances which change character completely under varying conditions. It appears to be as innocuous as the fizz in ginger ale, but it can be quite a demon when dissolved in condensed steam and when permitted to chew away at unprotected steel, iron, or copper fittings in lines.

Obvious retort to this situation is, "Why not eliminate CO_2 ahead of the steam-condensate system?" This makes sense, of course, and it can be done and is being done. Acidification followed by decarbonation or blending of hydrogen zeolite and sodium zeolite streams plus decarbonation are possible approaches. Dealkalization by ion exchange has application in some instances. Elimination of the use of soda ash in pretreatment or in the internal treatment of boilers can be a step in the right direction.

Quite often, however, it is economically difficult to avoid the use of soda ash in the pretreatment of boiler make-up when using raw water of low pH for the very high permanent hardness. Such waters are characteristic, for instance, of the upper tributaries of the Ohio River where acid mine drainage lowers the pH and contributes permanent hardness in the form of calcium sulfate.

Lime-soda softening is widely used both to soften and clarify such waters. Calcium sulfate hardness is reduced by combining with the soda ash to precipitate calcium carbonate. The greater the soda ash excess carried in the softener, the greater the reduction in the hardness. And it follows that the lower the hardness in the feedwater, the less sludge there will be in the boilers as a result of phosphate conditioning of the boiler water.

This is good practice, of course, for the boilers, but large soda ash excesses inevitably result in the accumulation of considerable CO_2 in the condensed steam due to the breakdown of soda ash (sodium carbonate) to caustic soda and CO_2 in the heat and pressure of the boilers. The solution of CO_2 in the condensate lowers the pH and results in the characteristic grooving-type of attack of lines and fittings.

Solving the Problem

This was exactly the situation faced by the operating personnel at the Desulfurization Plant of the Clairton Works of U. S. Steel Corp several years ago. Steam high in CO_2 content was utilized to heat the reboilers on a stripper column. The condensate formed in the reboilers was collected and used as make-up for two 15,000 lb per hour boilers in the open hearth area.

Not long after the start-up of this unit, the Mason-Neilan steam condensate control valve plugged with a deposit which proved to be a mixture of ferric oxide, hydrated iron oxide, and magnetic iron oxide — obviously corrosion products. Further investigation revealed serious corrosion in the condensate storage tank and the distribution system. An analysis of a sample of condensate from the impeller chamber of the condensate pump revealed the presence of 0.25 ppm total iron and 8 ppm of CO_2.

Therefore, not only was the obvious corrosion at the Desulfurization Plant of immediate concern, but also the deleterious effects which the iron oxide in the condensate would have when carried into the open hearth boilers.

When asked to review the situation, Hall Laboratories offered two immediate recommendations: 1. installation of vents on the reboilers, and 2. the feed of a filming amine to reduce corrosion. Both recommendations were followed at once.

Six weeks later the corrosion rate had been reduced to less than 0.1 mg/dm²/day. Three months later the rate was down to 0.03 mg/dm²/day. A second condensate sample at this time indicated that the CO_2 was unchanged at a level of 8 ppm but that the total iron had been reduced to 0.05 ppm from a level of 0.25 ppm before treatment with Hagafilm.

Corrosion test units in this system are now examined at approximately yearly intervals. The latest check indicated the corrosion rate to be so low by visual examination that the panels were re-exposed for a second year without weighing.

Hagafilm is fed directly to the steam header leading to the reboilers by means of a small Manzell pump. The emulsion form of Hagafilm is used to prepare the feed solution. Feed is essentially continuous at a rate of 1 to 2 ppm (solid basis) based on the steam flow.

Actually, the efficacy of filming amine in reducing condensate corrosion in this instance is not exceptional. Filming amine treatment has proved to be equally effective in all sizes and types of condensate systems from the largest utility station to the smallest apartment house steam heating systems. The wide applicability, ease of handling, and effectiveness have brought to filming amines wide recognition.

* Manager, Boiler Water Chemical Sales, Hagan Chemicals and Controls, Inc

Flame-Ceramic Process Applies High-Temperature Coatings

This recent development should find ever-increasing applications in the power engineering field as it offers, among other things, resistance to high temperatures, abrasion, chemicals

By GEORGE R. SYLVESTER*

A BRAND-NEW TECHNIQUE, known as Flame-Ceramics, was developed by Armour Research Foundation — of Illinois Institute of Technology — in 1956. The rights to this amazing process were acquired by our company, and development work was started immediately.

Flame-Ceramics is a patented process of flame-spraying ceramic substances onto a wide range of substrate materials. The ceramic powders are applied through the medium of a light spray gun or torch, the ceramic particles being sintered in an oxy-hydrogen flame, just beyond the nozzle of the gun. The powders are carried by the oxygen stream, which feeds through a pedestal hopper.

Because the fine powder-grains present very large surface areas to the flame, the heating is accelerated, and the coating can proceed at high speed. The torch, not being gravity operated, can be used in any position. Because of the smallness of the nozzle, and the availability of nozzles of varying lengths, it can be used effectively for inside diameters of very small dimensions.

Characteristics

A considerable number of ceramic coatings have been developed, each having special properties and characteristics. Among these are high-temperature resistance, chemical resistance, abrasion resistance, electrical conductivity and insulation, and chemical inertness.

Certain of the coatings have a temperature resistance of up to 5500 F; also, a hardness (with some) of up to twice that of tool steel. Sufficient mechanical strength, for the ceramic shell to remain intact after the metal under-material has been melted away, is another important property. The bonding of the coating is mechanical.

* President, Continental Coatings Corporation

Fig. 1. Two diesel engine pistons, showing practical results of flame-coating. One on left (coated) is free of varnish and carbon; other piston was not coated

The most frequently used Flame-Ceramic coatings have the following bases: alumina, zirconia, titania, rare-earth oxides, mullite, nickel-oxide, nickel-zirconium oxide, iron-titanium oxide and iron-titanium-alumina oxide.

Diesel Application

Among the first successful applications of Flame-Ceramics was in the field of railroad diesels, by C&EI Railroad, under the direction of Engineer of Tests, R. A. Bardwell. C&EI had been attracted by the reported high-temperature resistance characteristics of Flame-Ceramic coatings.

The first plan was to test the process in connection with C&EI's Budd Diesel Car that was hauling passengers daily between Chicago and Southern Illinois. This Budd Car is powered with a six-cylinder Detroit Diesel, which comes to the shops weekly for inspection and service.

The equipment pulls a standard Pullman car, which constitutes a special burden on the engine. This service is hard on lubricating oil, oil filters, and on the engine parts themselves.

However, the railroad did not begin with the Budd Car, but with its big General Motors EMD Diesels. In December, 1957, when a 1500-hp diesel came to the shops for repairs, two of the piston crowns were sprayed with a Flame-Ceramic coating, and the locomotive was sent out on regular duty.

As this locomotive came in for routine inspection and servicing, the piston crowns, rings, and cylinder liners were examined through the air ports. Several items of interest were observed. First, it was discovered that the coatings appeared to be firmly bonded to the substrate, a matter of obvious importance, since doubts had existed as to the bonding.

Second, the rings appeared to be in good shape, and the ring grooves were clean. Also, and most interesting at this stage (because of the ease of observation), the air ports of the cylinder liners were remarkably free of the gummy deposits which cut off the intake of air and adversely affect the operations of the engine.

All Pistons Coated

It was then decided to coat the pistons of an entire engine. A General Motors 1500-hp 567 EMD diesel was again chosen, and the locomotive was sent out on routine duty. A careful check was kept on results. Routine blotter and centrifuge tests showed quickly that oil filter changes could be extended from the former routine of every 8000 miles, to every 20,000 miles.

Iron content in the oil was closely watched, also. Spectrographic analysis, after 50,000 miles, showed no more than some 20 ppm, while colorometric analysis showed only 18 ppm. (Twenty-five ppm is considered low for a good engine.)

In September, 1958, one of the pistons and its cylinder liner were removed. Examination showed that the Flame-Ceramic coatings had re-

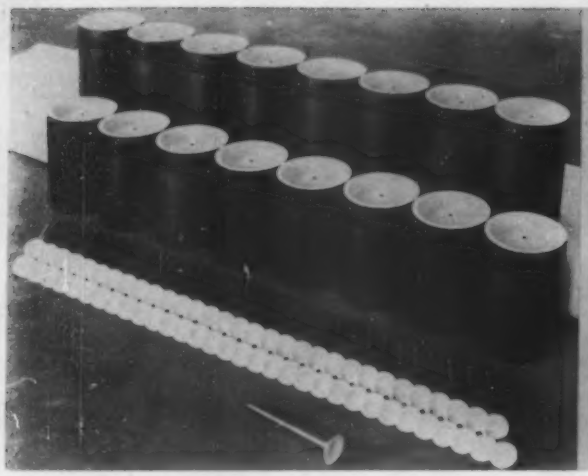


Fig. 2. Set of 16 cylinders and 64 valves, all flame-coated, ready for reinstallation in EMD railway diesel engine

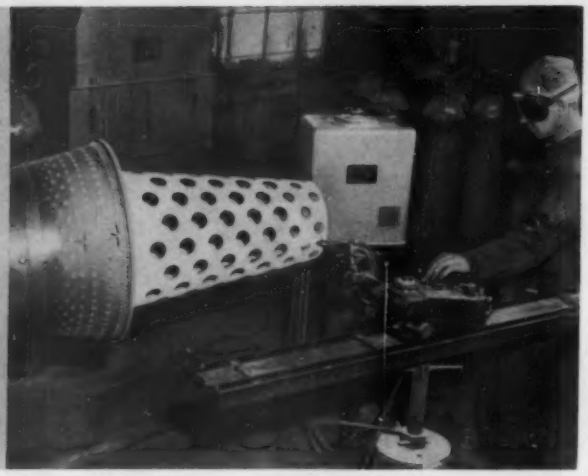


Fig. 3. Photo shows treating of combustor and inner cone assembly of Talos missile ramjet engine by flame-coating

mained well-bonded to the substrate, and were still of the original 0.004 in. thickness in many places, and never less than 0.003 in. The piston-skirts were free of varnish deposits, there was no carbon in the ring grooves, and the rings themselves were as good as new.

Of special interest was the cleanliness of the cylinder liner air ports. They were practically free of gummy deposits, whereas the air ports of the liners taken from other diesels in the shop showed a highly clogged condition.

Extension of the filter change-period, condition of the pistons, and cleanliness of the liners (and low content of iron), seem to justify the recommendation that coatings be applied to *not only piston crowns, but also valves and cylinderheads.*

Some twenty major railroads are today testing out Flame-Ceramic coatings in connection with EMDs, ALCOs and Detroit Diesels. Some are coating merely the pistonheads; some also valves and cylinderheads. These railroads are at different stages of testing. Preliminary reports, still of an informal nature, indicate a confirmation of the C&EI findings. And, in addition, the possibility of a fuel saving of between three and five per cent; also, the possible elimination of cracked cylinderheads.

Why are these results being obtained? The whys of the results are harder to come at. Our company has found no reason to disagree with C&EI's conclusion that *the ceramic coating tends to keep the heat within the combustion chamber*, preventing its dissipation through the piston — and insuring more complete combustion. "In theory," R. A. Bardwell has written of his Flame-Ceramic coated engines, "if combustion is more complete, the engine will either develop more horsepower from the same amount of fuel, or the same horsepower from less fuel."

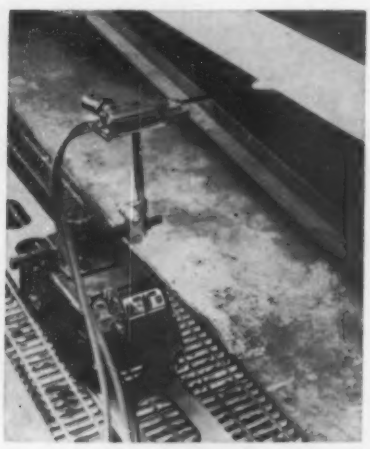


Fig. 4. Steel furnace roll is treated, to improve the quality of sheet steel

Silicon Steel Application

A further application of Flame-Ceramics has been in the manufacture of silicon steel. An old problem, perplexing the makers of this type of steel sheet, is that build-up on rolls, and dents in finished sheet, are universal — wherever continuous horizontal normalizing furnaces are used.

The build-up consists of small complex alloy deposits of chromium, silicon, and other metals that leave impressions on this strip (22 to 29 gage) at high processing temperatures. This build-up causes customers to reject the strip, because of its appearance, or because of its lack of flatness.

Since this steel material is used in electrical equipment, dimpling causes core-loss and decreases efficiency.

Roll build-up appears on the rollers that carry the strip through the hot zones of the normalizing furnaces, and presents an important maintenance problem. At Allegheny Ludlum Steel Corporation, Flame-Ceramics is being used (on a routine basis) to coat the surfaces of furnace rollers. Initial tests have been conducted at Brackenridge Plant near Pittsburgh.

Coated rolls have proved so satisfactory in Allegheny's smaller 216-ft normalizing furnace that they are now being used in another larger Allegheny unit. It has been established that the coated rolls develop only a small degree of build-up, which can be easily removed with the point of a knife. The process is being extended to other high-temperature applications.

Other Applications

These highly different phases of Flame-Ceramic use suggest its use in other fields. For example, blast furnace tuyeres, coated with Flame-Ceramics, have shown no sign of deterioration after a year's service. In the glass industry, the coatings have been effectively used — cast-iron chutes have been coated to permit glass to slide more rapidly, which is a substitute for the normal process of applying heavy oil or grease mixed with graphite. Flame-Ceramic coatings have been used in connection with rocket-nozzle tests, and the protection of crucibles in the steel industry.

In our Cleveland shops, an important range of coatings is moving forward in a steady procession. Immediately in progress are the coatings be-

Continued on page 117

Power Engineering handbook

Healthful Hints for Ladder Users

By K. D. CILLEY

SOME LADDERS, while in a somewhat worn condition, may safely withstand the weight of a light person, but may fail under a heavier person, or in the course of maintenance when some heavy object is being carried up the ladder, thus adding weight to be supported.

A wooden ladder which has been painted may be a death trap, in that while a coating of paint may look well it may also conceal serious defects that would otherwise be obvious.

Loose rungs or steps in wooden ladders permit side sway which may result in loss of balance to the user as well as possible side slipping of the ladder. Worn rungs or steps should be promptly and properly replaced, using the proper material.

Locks and guides of extension ladders as well as of step ladders should be inspected for rigidity, soundness and contact, so that there will be no danger of the ladder collapsing while being used.

Metal ladders, cat walks, fire escapes, etc, should be examined periodically for weakness due to corrosion, and where such are located in damp basements, outside of buildings or other areas where the atmosphere may cause unusual deterioration, they should be examined even more frequently in order to maintain safety. Cleaning and painting of these is encouraged, as it adds to their protection against deterioration.

Attachments which fasten vertical ladders to building walls, masonry, tank sides, etc, should be closely examined for broken rivets, bolts, welds or lag screws, as there is nothing more startling than to be near the top of a vertical ladder and have it suddenly pull away at the top; a serious fall is inevitable.

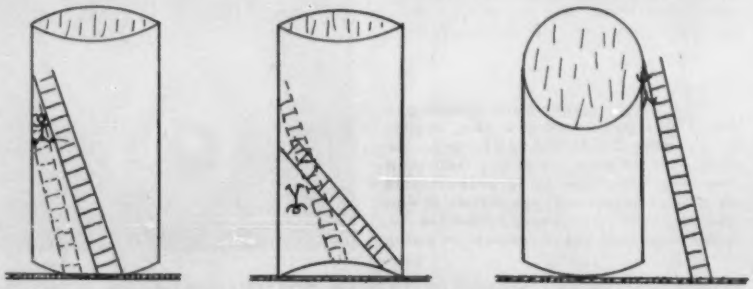


Fig. 1. Three hazards: slipping back on concave head, off crown of convex head, off side of vessel

The distance of rungs of a vertical ladder out from the sides of a vessel or wall to which it is attached is important because it is far safer to step on the rungs with the arch of the foot than with the toes or ball of the foot. As a rule of thumb, a distance of from 9 to 11 in. would be a reasonable distance for the average person. Many vertical permanently affixed ladders are constructed with a hooplike arrangement at the back, so that should the user lose balance and start to fall backwards, he would be caught by the hoop, giving him a chance to regain his balance.

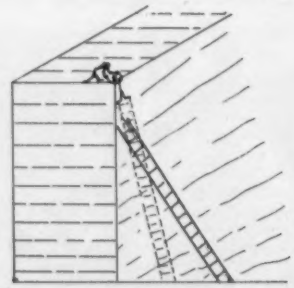


Fig. 2. Ladder too short to top wall

Ladders should never be used as bridges, even when boards or planks are placed over the rungs to form a walkway.

Positioning of ladders before going up or down is very important. A ladder should never be placed in a position which could cause it to slip in any direction. An acceptable distance from the bottom out from a wall is about one-fourth the ladder's length. Tying a ladder at the bottom is always good practice, to prevent it from slipping out, as well as tying the top to prevent it from slipping sideways.

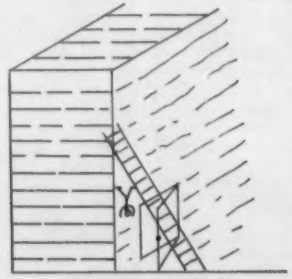


Fig. 3. Ladder placed in front of door

With unusually long extension ladders, there may be some sagging at the center when fully extended. A second ladder placed under the first, footed against the wall and lashed to the first at the center of the sag, will lend considerable support as well as confidence to the user.

Special care should be taken to prevent slipping when placing ladders inside vessels and boilers with uneven bottoms, or against concave or convex heads, inclined grates, walkways or steps.

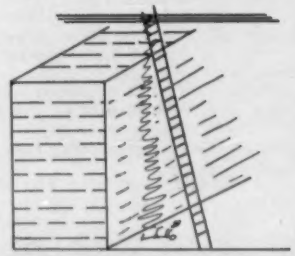


Fig. 4. Prevent contact with wiring

Crawling from a ladder through, over or under electric wiring is also extremely dangerous even though the insulation appears to be intact and in good condition.

Facing a ladder when going up or down should be a strict rule as this is the natural manner of climbing, and will prevent slipping resulting in possible muscle and back injuries.

Use of ladders where oil or ice is present adds to the hazards, and additional precautions should be taken. Ladders fitted with spikes or rubber-cleated feet are best, but sand or some such agent may also be scattered at the bottom to prevent slipping. Users should also see that their shoes are free of oil or ice before going up or down.

On Auxiliaries Under Operating Conditions

Based on sessions of the operators' training program conducted at Lakeside Station in Springfield, Illinois, by station superintendent F. H. Wilcoxon. Quiz sessions Nos. 1, 2 and 3 have covered lighting-off a cold boiler, safety hazard from bunker fires and pulverized coal firing, and cyclone-fired boilers.

DICK: I find it quite confusing. Some operators refer to "condensate" pumps and some to "hotwell" pumps. What is the difference between a hotwell and a condensate pump?

Chief: They are both the same. They are also called tail pumps.

Now I'd like to stress the importance of maintaining proper pressure and temperature on the deaerator. This is important because it removes the oxygen and non-condensable gases which cause corrosion and erosion. Also, proper control of the deaerator maintains a constant positive pressure on the boiler feed pump suction header and maintains constant temperature of the feedwater being pumped.

Jack: Why is it that when you put the evaporators in service, the pressure and temperature drops on the deaerator?

Chief: The 3rd stage bleed steam feeds the high pressure heater, deaerator, and 1st effect evaporators. If the load on the turbine from which the 3rd stage steam is being supplied is not high enough, the additional steam going to the 1st effect evaporator causes the 3rd stage pressure to drop, until the evaporators are properly vented and up to full vacuum and temperature, after which the amount of steam used by the evaporators would be less and the deaerator would then return to normal pressure and temperature.

Lon: Why do the gland seal tanks run dry at night when the turbine is down?

Chief: It may be that some of the turbine gland seal valves are leaking or have dirt under the seat. Also, there are drain valves on this tank, which discharge to the sewer. These may also be leaking and should be checked. There have been cases where the gland seal tank would overflow because the float valve did not shut off. The surge tank elevation is above the gland seal tank. That is why the gland seal tank supply valve is closed when a unit is shut down.

Lon: What does the deaerator look like inside?

Chief: The upper three or four feet of the deaerator are full of shallow trays that are filled by condensate which sprays into the trays. These trays are constantly spilling over droplets of condensate which are heated by 3rd or 7th stage bleed steam applied under the trays. This steam passes through the trays and on up into the vent condenser where it is condensed and drains back to the lower part of the deaerator. The oxygen and non-condensable gases vent out to atmosphere. The lower portion of the deaerator serves as a storage space for the heated and deaerated condensate.

Jack: You talked about low pressure and high pressure heaters and 3rd and 7th stage bleed steam. What are these? In the heaters, does the steam go through the tubes?

Chief: The difference between the high pressure heater and the low pressure heater is that the high pressure heater tubes are subjected to boiler feedwater pressure which must be higher than the boiler pressure and uses 3rd stage steam, which is the highest pressure steam from the turbine. The low pressure heater tubes are subjected to condensate pressure, which is only high enough to force the condensate up to the surge tanks, and the steam is from the 11th stage or low pressure bleed steam from the turbine. The various stages of bleed steam are numbered from the high pressure and increasing toward the low pressure end.

Joe: Doesn't the feedwater pick up air when it is churned around in the BF pump?

Chief: It would be impossible for the boiler feedwater to pick up oxygen at the pump, because the suction is under a positive pressure and the pressure inside the pump is higher than atmospheric pressure.

Tom: What is the best thing to do when the deaerator pressure gets too high?

Chief: The first thing to do is to crack the by-pass valve on that deaerator, so you will be sure to keep water in the suction header; then go up and close the steam valve to the deaerator, to keep the pressure from getting too high.

Tom: Can you by-pass the heaters and still carry load?

Chief: There are by-passes on all the heaters and also the deaerators.

Tom: What is the minimum temperature of the water going to the boiler?

Chief: With the high pressure heaters shut off, the feedwater temperature would be about 210 to 215 F. If the low pressure heater were by-passed, it wouldn't affect operation very much. You should be able to maintain normal feedwater suction temperature with the deaerator. The lower the feedwater temperature going into the boiler, the harder you have to fire the boiler, and you may cause excessive superheat temperature.

Joe: What is meant by IA condenser? What does the "IA" stand for?

Chief: That means "inter-after." The inter-side is under condenser vacuum and the after-side exhausts to atmosphere. The first stage jets pull the air from the main condenser and discharge to the inter-condenser. The 2nd stage jets pull the air from the inter-condenser and discharge it to the after-condenser, which also discharges to atmosphere. In the Navy we used to use just the 2nd stage jets, so the vacuum would not get too high when starting a turbine. This would warm up the turbine more quickly.

Dick: Do all the superheater drains from the boiler discharge to the blow-off tank?

Chief: Yes.

Dick: Then all of that heat and condensate is lost?

Chief: Yes. The only way you could recover this is to run the drains through a heater and return it to storage; but it is necessary to keep the steam flowing through the superheater tubes to keep from burning them up.

Dick: There seems to be a lot of steam and condensate wasted each time a boiler is put on. It looks as if there should be a way to save this.

Chief: There are two reasons why we do not try to save the steam and condensate from the superheater drains. First, it is in violation of the boiler code to connect the superheater drains to a closed heater; and second, considerable concentration of impurities is found in the drum and superheater elements, which would contaminate the condensate during boiler start-ups.

Joe: It would seem that all exhaust steam coming from the turbine would be at the same temperature.

Chief: The pressure and temperature depend on what stage the steam is bled off, with respect to the turbine cylinder. It goes in at the 1st stage and drops in pressure and temperature from the front to the back of the turbine cylinder. After you get a certain amount of work out of the steam in the turbine, you bleed it off and use it for heat recovery in the various heat exchangers.

Joe: I understand that phase of the cycle, but why is it that you use the 3rd stage steam in the high pressure heater and the deaerator but yet have different condensate temperatures?

Chief: This is because you control the pressure in the deaerator at 3 to 5 lb while the high pressure heater shell pressure varies with the 3rd stage pressure, which may get as high as 150 to 200 lb. For every pressure there is a corresponding temperature.

Tom: When you start up the next unit, how will you fill the condensate system?

Chief: We will have the storage tanks full and this will be sucked into the hotwell by use of the starting ejector, to pull a vacuum on the main condenser. The condensate will then be pumped from the hotwell into the system until the surge tanks are full. The deaerator will then be filled and suction header, feed pumps, boiler feed discharge header and up to the boiler drum. When the

POWER ENGINEERING HANDBOOK

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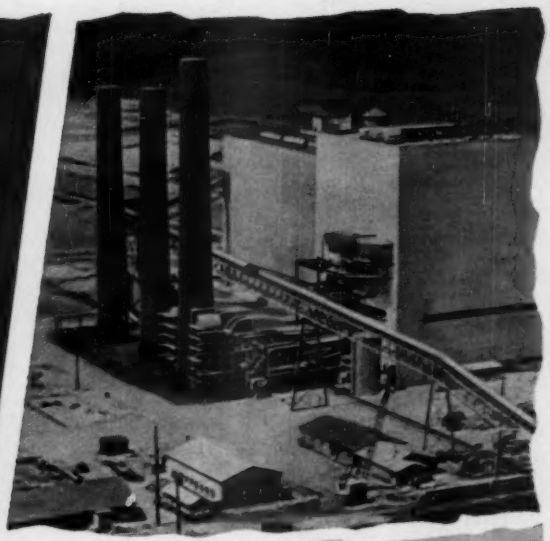
plant designs...



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boiler is filled up to starting level, we are ready to light-off.

Prior to all this we must flush and clear all of the system of slag, weld material, and any other foreign material which would contaminate the system and damage the pumps and equipment. The boiler must also be boiled out with chemicals and flushed until it is free of grease, rust, scale, and other material which may have been left inside during erection.

Joe: Doesn't the condensate in the storage tanks become contaminated?

Chief: It picks up oxygen and some dust and dirt which may be in the air. This is controlled by checking the condensate in the system periodically.

Air Velocities for Industrial Ventilation

By JOHN D. CONSTANCE, P.E.

TABLE BELOW shows quickly and clearly air velocities that have been found helpful as a guide in many industrial ventilation applications. The ranges recommended here should provide for systems practically free from excessive noise, vibration, pulsation, or drafts. The limits may be used for design or a performance check on installations.

All velocities are for gross or full areas. When both heating and cooling coils are placed within the same casing, the controlling velocity is that of the cooling coil.

CONDITION	VELOCITY FPM
AIR DISTRIBUTION	
Duct velocities	
Very quiet	1000–1400
Quiet	1400–1600
Ordinary	1700–1900
Industrial	2000–2200
Outside Air Intake	500–800
Return Air Intake	
At ceiling	600–800
At floor	300–500
Corridors	up to 50
Supply Grilles	400–800
EQUIPMENT	
Heating coils	500–700
Cooling coils	450–650
Air filters	400–600
Preheater	700–900
Preheater bypass	900–1000
Reheater	700–900
Air washer	400–500
Washer return	1000–1500
Washer bypass	1000–1500
Electrostatic precipitator	300–400
Gravity louvers	100–200

CONDITION	VELOCITY FPM
Fan discharge	
@½" s.p.w.g.	1000–1200
¾"	1300–1500
1"	1500–1800
1¼"	1600–1900
1½"	1800–2100
1¾"	1900–2200
2"	2000–2400
Spot Cooling (Human Comfort)	200–300
SUCTION VELOCITIES	
Dust released without noticeable movement	50–100
Evaporation of vapors, plating, welding	
Released with low velocity	100–200
Paint spraying w. booth, barrel filling, rotating mixers	
Active generation	200–500
Foundry shakeout, crushing, screening	
Released with great force	500–2000
Grinding, tumbling mills, abrasive cleaning, metal working	

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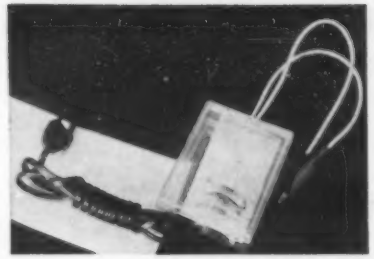
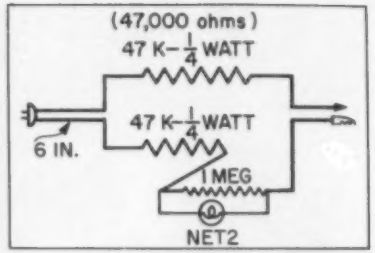




Here's a Handy All-Purpose Continuity Tester

By HARRY J. MILLER

THIS SIMPLE continuity tester is compact enou h to fit into the pocket or tool boxes of maintenance men, performs a variety of on-the-job tests, and saves time and legwork in shooting electrical faults.

The unit is housed in a small plastic box, and is wired with a few feet of parallel plastic lamp cord and a pair of 6-in. leads that terminate respectively in a probe and an alligator clip (see photograph and sketch).

On a piece of asbestos shingle or heavy asbestos board, mount the few components by their own leads. Tie a knot to relieve any strain on the two test leads. The NE T 2 neon bulb is the indicator. Note that presence of a resistor in each leg of the two test leads minimizes shock danger.

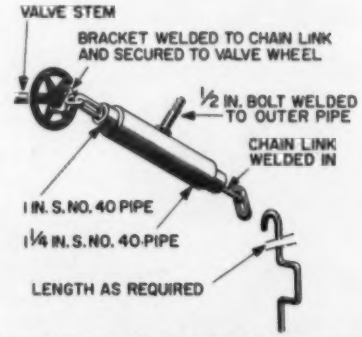
Getting at That Hard-to-Reach Control Valve

By ANTHONY M. GARCIA

OUR BRINE REFRIGERATION systems cool three rooms with changing heat loads. The brine is sprayed onto overhead decks and is the same temperature in each cooler; so to control the room temperature the volume of spray must be controlled.

The control valves are in a difficult place to reach (overhead), the valve stems are parallel to the floor, and the brine deck overhang prevents the use of a reach rod.

Sketch shows the arrangement which we worked out to solve the problem, which it does very satisfactorily when bolted to a suitable bracket and operated by a reach rod. We have had six such controls in use for the past two years, and our operating engineers are well satisfied.


VALVE STEM
BRACKET WELDED TO CHAIN LINK AND SECURED TO VALVE WHEEL
½ IN. BOLT WELDED TO OUTER PIPE
CHAIN LINK WELDED IN
1 IN. S. NO. 40 PIPE
1¼ IN. S. NO. 40 PIPE
LENGTH AS REQUIRED

Length of each pipe can be chosen to suit the need. Outer pipe is secured to a suitable bracket at hand

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CONSTRUCTION NEWS

Nabeola, Ala. — Alabama Power Co, Alabama Power Bldg, Birmingham, Ala, through efforts of its own engineering forces, plans to construct a 110,000-v transmission line and substation to serve the new processing plant of the Marathon Southern Co, recently located here. Work will begin soon on the installation, which will be completed in the fall of 1961.

Barstow, Calif. — California Electric Power Co, 3771 E. Eighth St, Riverside, Calif, has started work on the construction of a steam-electric power plant near here, about 100 miles due west of Los Angeles, Calif. Engineering work has been completed, and plans call for the steam-electric generating unit, with an initial capacity of 62,000 kw, to use gas as fuel. Cost of the plant is estimated at about $14,000,000 and is scheduled for completion by late 1961. Similar units are planned as needed.

Long Beach, Calif. — Southern California Edison Co, 601 W. Fifth St, Los Angeles, Calif, has plans under consideration for a major addition to its Alamitos Power Station, located here. A new steam-electric generating unit will be added to existing facilities. New unit will have an initial capacity of 220,000 kw and will cost approximately $43,000,000 when completed. Work will begin late this year for completion in about 2½ years.

Oroville, Calif. — Oroville-Wyandotte Irrigation District, P.O. Box 229, is considering plans to construct 4 earth and rockfill dams, 3 concrete dams, 17 miles of tunnels, 11,000 ft of penstocks, 3 hydroelectric generating plants, 23 miles of power and irrigation canals, and access roads to the Feather River Project, located in Butte, Plumas, and Yuba counties. Proposed project will represent an investment over $50,000,000.

Bridgeport, Conn. — United Illuminating Co, 80 Temple St, New Haven, Conn, has begun work on underground installations to its electrical distribution system, including a Bridgeport Harbor cable to Yellow Mill Pond, Bridgeport, and 2½ miles of underground electric cables to Skiff St, Hamden, Conn, at a cost approximating $450,000. Extension of company's transmission lines to North Bridgeport is also planned at an additional cost of about $100,000, making a total expenditure of $535,950. Preliminary work is already under way, and project is scheduled for completion by spring of 1961.

Lemont, Ill. — The Atomic Energy Commission, 1901 Constitution Ave, N.W., Washington, D.C., has announced a contract award to the Turner Construction Co, Chicago, Ill, in the amount of $1,184,000 for additions and improvements in the AEC's Argonne National Laboratory, located here. Company plans to build a control building and an injector building for the zero gradient synchrotron, a type of atom smasher. Work will begin at once and is scheduled to end by the summer of 1961.

Paradise, Ky. — Tennessee Valley Authority, New Sprankles Bldg, Knoxville, Tenn, is considering plans to construct a large generating plant to house the largest steam-turbine generator in the world. New plant will be built on the west bank of the Green River, on a large site, near this city, in the northwestern part of TVA's power service area, adjacent to the vast coal fields in the immediate area. Plans include the installation of a steam-electric generating unit with an initial capacity of 600,000 kw in the plant which will cost a reported $100,000,000 when completed.

Shreveport, La. — Southwestern Electric Power Co, 428 Travis St, this city, has authorized plans to construct a 49-mile, 161,000-v transmission line from Springdale, Ark, to Boudinot, Okla, including necessary substations and auxiliary equipment. Construction of the new line will begin later this year and is scheduled for completion by the spring of 1962.

Newport, Minn. — Northern States Power Co, 15 South Fifth St, Minneapolis, Minn, has authorized plans for the construction of a huge steam-powered generating plant on a 286-acre site, recently acquired by the utility for the purpose, on the Mississippi River, just south of St. Paul. Construction of the plant is projected into the future and will probably not begin for several years. Cost of the 1,000,000-kw plant is estimated at between $170,000,000 and $180,000,000. Company currently has under way construction facilities with power-generating capacity of 240,000 kw.

Indian Point, N. Y. — Consolidated Edison Company of New York, 14 Irving Place, New York, N. Y., has announced that work on its 275,000-kw atomic power plant, at a location here on the Hudson River just 25 miles north of Manhattan, is proceeding according to plan. The project, now more than 60 per cent completed, represents an investment of more than $100,000,000, including site, construction of the plant, and equipment costs. An idea of the job's mammoth size, as well as the extensive planning that has gone into the project, is the figure of more than $9,000,000 spent on research and design before a construction worker ever appeared on the site. The turbine-generator portion of the plant is located on level ground next to the river, while the reactor structure and its service buildings are cut into the rock behind.

New York, N. Y. — Power Authority of the State of New York, Coliseum Towers, 10 Columbus Circle, New York, N. Y., has announced conclusion of a two-year struggle between the Authority and the Tuscarora Indians with reference to the Niagara Power Project, which, when completed, will cost over $720,000,000. Main effects of the decision will be enlargement of the pumped-storage reservoir and an increase of 100,000 kw in the installation's generating capacity. The reservoir question has had no effect on powerhouse design since work on the project has been going ahead steadily. No change is contemplated for the 2.19 million-kw of installed capacity.

Harrisburg, Pa. — General State Authority, 18th and Herr streets, has authorized plans for the reconditioning and expansion of electrical and plumbing systems at State Finance Bldg, located here. Work on the project will begin soon for completion by the fall of 1961. Cost is reported to be about $3,000,000.

Parr Shoals, S. C. — The Carolinas-Virginia Nuclear Power Associates, Inc, headquartered in Charlotte, N. C., has been authorized by the Atomic Energy Commission, 1901 Constitution Ave, N.W., Washington, D. C., to construct a nuclear power plant at this location. The company is a non-profit organization, and its construction permit is provisional until the company provides evidence that the health and safety of the public is adequately protected. Work on the plant will begin late this year, and its cost is reported to be over $43,000,000.

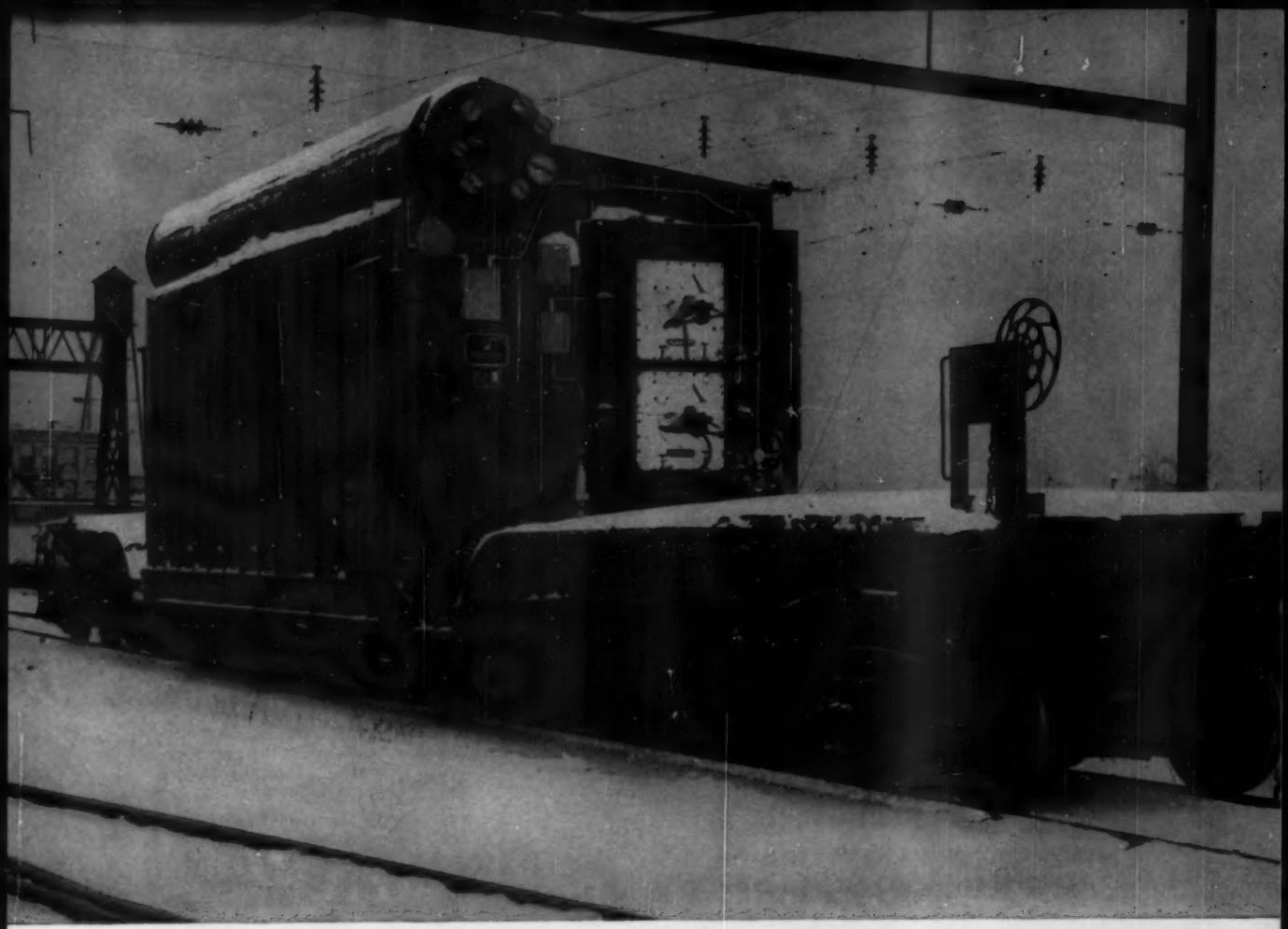
Denton, Texas — Municipal Electric Dept, City Hall, has plans in progress for expansion and improvement in the municipal steam-electric power plant with installation of equipment for increased capacity. Work will begin when preliminary engineering is completed. Installation is reported to cost $4,750,000, will be completed by the fall of 1961.

Salt Lake City, Utah — Utah Power & Light Co, Kearns Bldg, this city, has announced a construction program involving the expenditure of more than $120,000,000 for expansion and improvement of its system over the next 4 years. Company forecast construction outlays for this year at $16,700,000; in 1961, $18,800,000; in 1962, $26,800,000; in 1963, $28,100,000; and $19,600,000 in 1964. Company's outlay for construction of new facilities in 1959 was approximately $14,000,000. Work will be financed through a bond issue planned for this fall.

Roanoke, Va. — Appalachian Power Co, 129 Campbell Ave, a major operating company of the American Electric Power System, has announced contract awards in the amount of $11,500,000 through American Electric Power Service Corp, for equipment for the proposed Smith Mountain hydroelectric project on the Roanoke River, consisting of two dams, 17 miles apart downstream from here, at a construction cost of approximately $43,000,000. Generating capacity of 285,000 kw will be installed at the upstream powerhouse and a unit of lesser capacity at the downstream plant. Reversible turbines are planned at the downstream powerhouse to pump water into a storage reservoir for use in power generation during peak demand periods.

Apple Valley, W. Va. — American Electric Power Service Corp, a subsidiary of American Electric Power Co, 30 Church St, New York City, N. Y., and Westinghouse Electric Corp, Pittsburgh, Pa, have announced joint plans for the construction and operation of a 750,000-watt test electric transmission line. Electric utilities operate transmission systems at a maximum of 345,000 v, and some experimental lines in this country have been operated at a maximum of 500,000 v. New line will be used to determine the feasibility of transmitting power at such high voltage. It will be built along the Ohio River at this location.

Laramie, Wyo. — Board of Trustees, University of Wyoming, Campus, Laramie, Wyo, has authorized contract award in the amount of $524,332 for boiler system expansion and installation of approximately 6600 ft of walk-in-type tunnels on University Campus, to the Garton Utilities Company, Cheyenne, Wyo.



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The Chemical Treatment of Boiler Feed Water. This technical bulletin contains a clear explanation of the causes of boiler water problems and Western's methods of solving them. Special emphasis on scale prevention, corrosion control, sludge dispersion, and suppression of foaming and carry-over.

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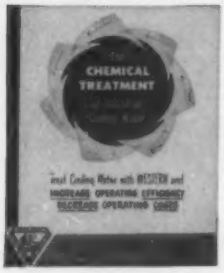

The Chemical Treatment of Industrial Cooling Water discusses common cooling water problems—scale, corrosion, algae, slime. Also presents Western's proven methods for controlling and preventing these conditions in cooling towers, evaporative condensers, process heat exchangers, engine and compressor jackets, chilled water systems, etc.

Better Fuel Performance and Economy discusses the causes and effects of sludge in fuel oil supplies and soot deposits in combustion areas. Shows how these troubles can be eliminated economically, dependably, and permanently with time-tested special Western formulas.

Also, Technical Bulletins on the chemical treatment of potable and plant water supply—refrigerating brine—sweet water systems. Also, the use of Dry Acid Scale Removers.

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Whatever your water, steam or fuel treatment problem may be, you can rely on special Western formulas and individual technical service to solve it dependably and economically.

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NEW ENGINEERING BOOKS

The Internal-Combustion Engine in Theory and Practice Vol. 1 (Thermodynamics, Fluid Flow, Performance), by Charles Fayette Taylor; 574 pages, 6 by 9 in. Published by John Wiley & Sons and Technology Press of Massachusetts Institute of Technology. Price, $16.

According to the author, an attempt has been made to present the material so that it can be used, both quantitatively and qualitatively, to solve practical design problems. To achieve this end, design information is profusely and authoritatively presented in the form of curves, charts, and tables.

This volume begins logically by introducing symbols, units, and definitions vital to a thorough understanding of the study.

Many features have not heretofore been available in convenient form. They are: 1. Generalized characteristics of constant-volume and limited-pressure ideal cycles, based on thermodynamic characteristics of mixtures of air and petroleum fuel; 2. relation of actual engine cycles to the corresponding ideal fuel-air cycles; 3. studies of the air-capacity and fluid-flow characteristics of four-stroke and two-stroke engines; 4. generalized performance curves of different types of compressors; 5. an analysis of the influence of cylinder size on engine characteristics; and, 6. methods of performance analysis and prediction, and typical generalized performance curves of various engines, compressor, and turbine combinations.

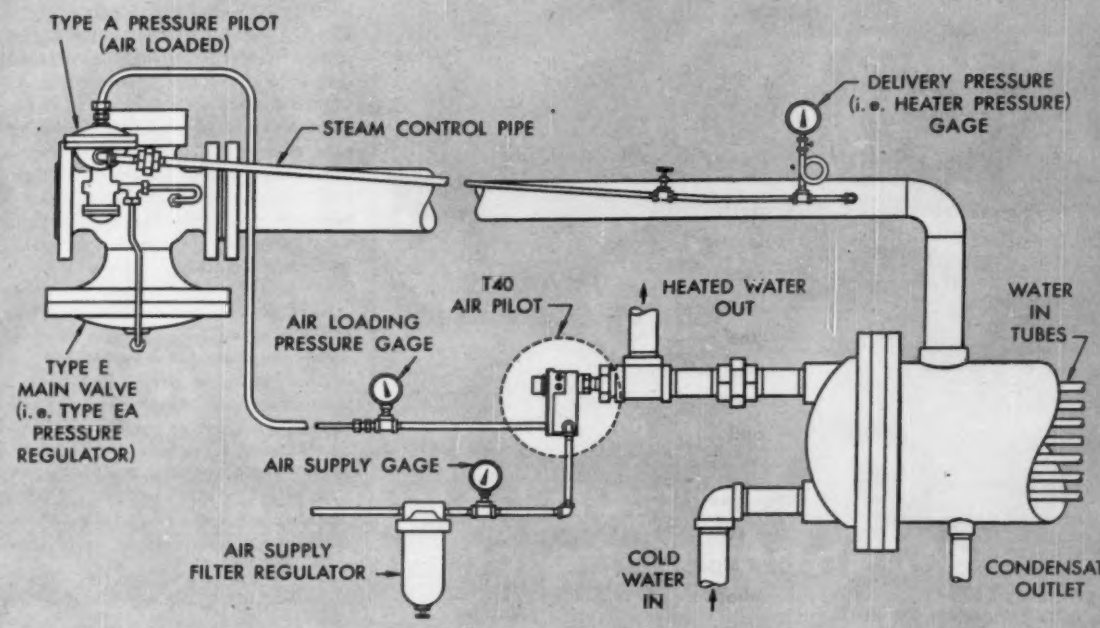
★ ★ ★

Electronic Computers: Principles and Applications, by T. E. Ivall; 263 pages, 5½ by 8½ in. Published by Philosophical Library, Inc, 15 E. 40th St, New York 16, N. Y. Price, $15.

In this second edition of a book first published in 1956, the author has rewritten most of the chapters, replaced most of the diagrams, and added illustrations of more modern electronic computer devices. The growth of interest and technology in electronic computers is exemplified by the addition of three chapters dealing with analog computer circuits, programming of digital computers, and the evolution of the more "intelligent" machines of the future.

In the chapter on recent developments, Mr. Ivall predicts that the thermionic valve gradually will disappear from computers and be replaced by the transistor, a minute device that works on the diffusion of electric current carriers through solid semi-conductor materials such as germanium and silicon. Cited are other features which will make transistors ideal for use in digital computers; on the other hand, Ivall reveals that some transistors are not so ideal. Further explained

New Spence Temperature Control System Gives Unusual Control Accuracy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HEATED WATER OUT
WATER IN TUBES
AIR LOADING PRESSURE GAGE
TYPE E MAIN VALVE (i. e. TYPE EA PRESSURE REGULATOR)
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AIR SUPPLY FILTER REGULATOR
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TYPE EAT40 AIR-CONTROL TEMPERATURE REGULATOR (Patent Pending)

In a recent installation the new Spence air-control temperature regulating system provided:

- ±5°F control accuracy under wide and instantaneous load swings of 210 to 80 gallons per minute.
- Up to 50% reduction in cost as compared to instrument systems of similar accuracy.

This unique cascade-type control with throttling range adjustment independent of maximum heater pressure was developed to meet today's demand for greater control accuracy.

Additional features of the new Spence Temperature Control System include:

- 200°F wide adjustable temperature range
- Adjustable speed of steam pressure change
- Over and under temperature protection
- Pressure limit control
- Fast response
- Very low air consumption
- Field reversible for heating or cooling

The Spence Type EAT Air Control Temperature System, when properly installed, will tame wide ranging, fast changing loads of instantaneous heaters and modern heat exchangers. The cascade principle plus the use of an extremely fast responding bi-metal temperature sensing element reduce time lags and provide control stability.

Here's how the new Spence system operates:

Quick response is based on a bi-metal temperature sensing element. Temperature pilot continuously regulates a loading air pressure.

This loading signal, when applied to a pressure regulator to reflect heater temperatures, causes it to adjust the main valve as changes in load require.

Spence has also developed a new pressure control system based on this same cascade principle. This system has a control accuracy of ½ psi or better from positive pressures through the vacuum range to 30" Hg.

For complete information on these new air controlled temperature and pressure control systems, write for your copy of Bulletin 9.

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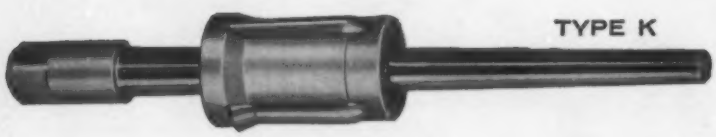

This 16-page bulletin describes general types of Elliott boiler tube expanders for fast, efficient tube rolling jobs. It also gives dimensions, prices and other descriptive data and shows various drum, header and short series mandrels which are used with Elliott boiler tube expanders. Drum mandrels are seen with Type M and Type K above.

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Y7-8

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in this chapter are the development of the cryotron, and the magnetic storage principle.

The book is well-formulated to present a non-mathematical introduction to technicians, engineers, and students who have some knowledge of electronic or electrical engineering. Even the interested layman will find much value.

★ ★ ★

Electrochemical Engineering (Fourth Edition), by C. L. Mantell; 680 pages, 6 by 9 in. Published by McGraw-Hill Book Co, 327 W. 41st St, New York 36, N. Y. Price $16.50.

Another volume in McGraw-Hill's Chemical Engineering Series, Dr. Mantell's treatise, originally titled *Industrial Electrochemistry*, has been almost completely rewritten to reflect the tremendous expansion since 1950 in the electrochemical and electroprocess industries.

Seven sections on theoretical electrochemistry, electrolytics, fused salts, electrothermics, electrochemistry of gases, chemelectrics, and engineering emphasize industrial processes while presenting enough fundamental theory also to provide a background for industrial practice.

Dr. Mantell's original study is strengthened by new information on electrorefining of nickel, cobalt, lead, and other metals not previously processed electrochemically. He also has added new data on fluorine and alkali sulfates and a new section on hydrochloric acid. These are just a few of the new sections and data compiled in a study which both chemical engineering students and practicing engineers will find to be a valuable aid to understanding the commercial and engineering phases of the electroprocess industries.

★ ★ ★

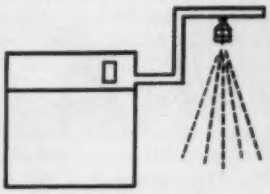
Power Station Engineering and Economy, by Bernhardt G. A. Skrotzki and William A. Vopat; 751 pages, 6 by 9 in. Published by McGraw-Hill Book Co, 327 W. 41st St, New York 36, N. Y. Price, $12.50.

Finding a demand for more depth and wider scope in outlining the elements of a power-generating system as represented by the wide variety of today's power plants, the authors have reorganized and rewritten this second edition of a study originally titled *Applied Energy Conversion.*

The main intent of the book is to emphasize principles of operation rather than to study the minute details of equipment design. Five parts discuss energy processing, steam power plants, internal-combustion plants, hydro and meteorological plants, and power economics.

A unique feature is the inclusion of problems at the end of each chapter, a device which offers good opportunity actually to apply newly-learned principles.

Book's fine format, including type faces, drawings, and tables, will be appreciated by the reader.



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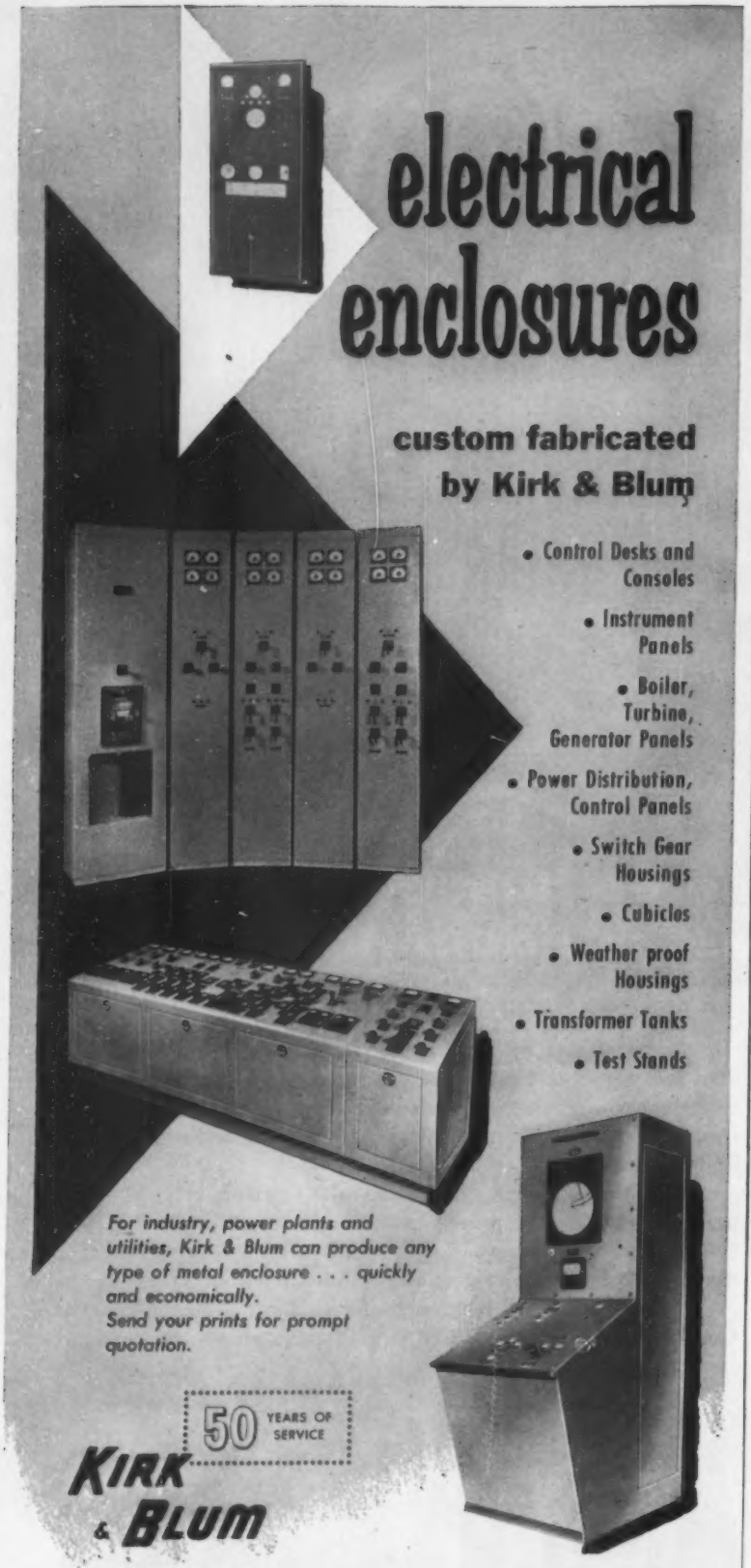
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Applied Solar Energy Research, edited by Jean Smith Jensen; 275 pages, 8 by 10¾ in. Published by Association for Applied Solar Energy, 3424 N. Central Ave, Phoenix, Ariz. Price, $7.50.

Broadening of interests and horizons in applied solar energy research is manifested by this volume's directory of world research activities in 25 countries ranging from Burma to the Belgian Congo. A voluminous bibliography lists 2916 reported cases of solar energy utilization.

Jan Oostermeyer, president of the Association for Applied Solar Energy, sums it up this way in the preface: "Mankind will one day reap countless benefits from the rays of the sun. Through services such as (this) publication . . . the Association hopes to bring that day closer to reality."

★ ★ ★

Civil Engineering Refresher for Professional Engineers License, by Robert Lipp; 8½ by 11 in., paper cover. Published by John D. Constance, 625 Hudson Terrace, Cliffside Park, New Jersey. Price, $3.50

The book's specific aim is to help prepare the practicing civil engineer to pass the civil engineering examination for Professional Engineer. Selections of problems with solutions are included, mainly from past examinations in a number of representative states. Subjects considered are surveying, highways, fluid mechanics, water supply and sewerage, structures, soil mechanics and foundations, and construction. To aid in the study, Mr. Lipp has listed several reference books.

★ ★ ★

Pipefitters Handbook, by Forrest R. Lindsey; 410 pages, 4 by 6¾ in. Published by the Industrial Press, 93 Worth St, New York 13, N. Y. Price, $6.

The book jacket states: "Written by a pipefitter for pipefitters." This is undoubtedly an understatement, for Mr. Lindsey has been at this trade for over thirty-five years. Material in this handbook represents a compilation of facts and figures made by the author during his career.

Information includes worked-out tables for pipe bends, offsets, mitered joints, pipe and fitting dimensions, and a host of other miscellaneous items useful to the fitter in shop and field. By providing on-the-spot answers to a host of pipefitting problems, the author's tables will aid in eliminating the need for lengthy calculations.

★ ★ ★

Standard Plant Operator's Questions and Answers, Vols. 1 and 2, by Stephen M. Elonka and Joseph F. Robinson; 518 pages, 5 by 8 in. Published by McGraw-Hill Book Co, 327 W. 41st St, New York 36, N. Y. Price, both, $14.95.

This set's subtitle states: "A modern license-examination review course for plant, refrigeration, steam, diesel, nuclear, electrical, and building engineers." The authors use a question and answer format in their treatment of the material. For further

Facts you should have on file under "stokers"...and "savings"

(File this page, send coupon now)

Whether your company will talk new stoker next month or three years from now, your review of stoker performance will not be complete without the facts on AE Vibra-Grate Stokers and the outstanding savings assured with the exclusive Vibra-Grate design.

The AE Vibra-Grate Stoker is the only stoker which combines the maintenance-savings features of water cooling and the high-efficiency features of a vibrating grate and controlled zone undergrate air.

Operating reports from some of the country's most cost-conscious companies now using Vibra-Grate Stokers are nothing short of phenomenal.

For example: A 40,000 lb boiler fired by a Vibra-Grate Stoker at S. C. Johnson & Son (makers of Johnson Wax Products) has never had an unscheduled shutdown since the stoker was installed in October 1954. Coal savings have averaged 919 tons per year. There has been no trouble with clinkers or coking coals. Total repair costs for the first five years, when 34,962 tons of coal were consumed, were only $188. A hair over ½ cent per ton of coal!

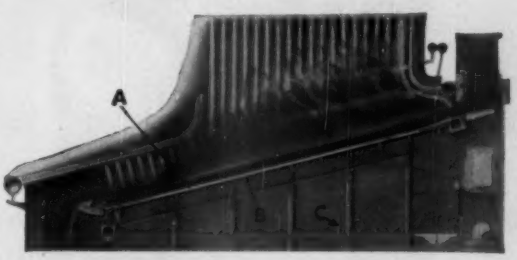
For example: At Spaulding Fibre Company, two Vibra-Grate Stokers have saved 2000 tons of coal in two years, compared with other stokers in the same plant. Average evaporation on one unit is 10.6 lb of steam, 10.8 on the other, using coals having an average Btu value of 13,173. The company writes, "... efficiency and operating economies far in excess of the manufacturer's guarantee and our highest expectations".

For example: Savings of $300 a day are reported by a major textile manufacturer. In this instance oil fired boilers were replaced by a 70,000 lb/hr Vibra-Grate Stoker. The unit is operating at 80.7% efficiency, even though the boiler has no heat recovery equipment.

For example: An old 40,000 lb/hr boiler was restokered with a Vibra-Grate for Edgewood Division, Pilgrim State Hospital, Brentwood, Long Island. Savings are averaging 8 tons of coal per day.

Highest efficiencies anywhere

Because the AE Vibra-Grate Stoker design is completely different you get a range and combination of advantages not possible with any other stoker.



The vibrating grate (A) insures compact distribution of fuel, and elimination of holes and light spots. Thus, the stoker can handle low or high volatile bituminous coal, as well as lignite and semi-anthracites—wet or dry.

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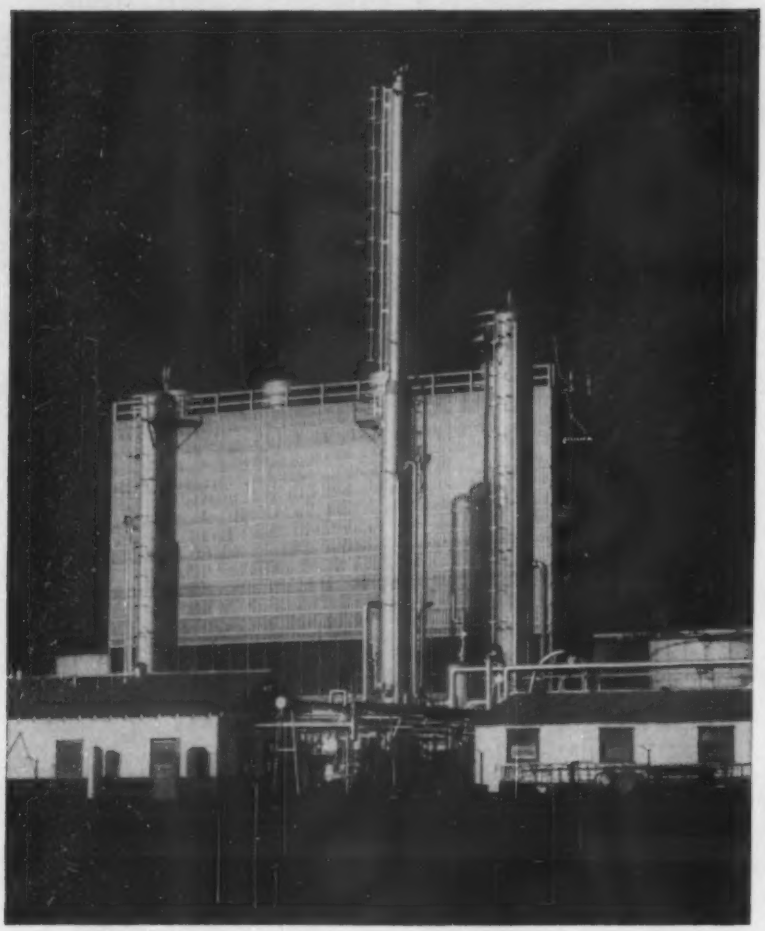

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Hagacides are effective against algae, slime, iron and sulphate reducing bacteria, and the complete spectrum of biological agents that impede cooling water operations. Hagacides are compatible with other water treatment chemicals; they are stable and are highly resistant to temperature extremes.

Easy to handle and feed, all Hagacides are completely safe for cooling tower wood. They are non-volatile, non-oxidizing and contain no corrosive metals. They penetrate and loosen debris which harbors microorganisms, and adhere to surfaces for a long lasting kill.

Hagacide biocides have proven themselves effective in situations where other biocides have failed. For more information, write:

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study of the topics discussed, suggested reference material is listed at the end of each chapter.

Purpose of the volumes is eight-fold. Among those who will find great value are plant and building operators and other practical men who want to pass examinations and improve their basic knowledge; industrial and utility firms that have a training program for upgrading employees; sales and service personnel, to gain a better background of plant equipment; and firemen, oilers, water-tenders, operators, and engineers as a study reference for upgrading or for obtaining an original license.

MORE ABOUT—

Turbo-Charged Plant

Continued from page 70

overseas. Pressurized gasifiers are in reasonably wide use there, and it has been found possible to cope with the high-ash coals which are encountered in England and on the Continent.

A new English process for complete gasification of high-ash coals without the use of oxygen is showing very encouraging results. Gas of 400 Btu per cu ft is being produced consistently, with *all* the ash being removed from the gasifier in the form of molten slag.

The gasification process offers many advantages, provided that it can be done in an apparatus which is no more costly than the fly ash separator shown in Fig. 3. Cleaning of the relatively small volume of gas can be done much more readily than removing fly ash from a much larger stream of high temperature combustion products, and to one who has spent a number of years in developing the apparatus required for Fig. 3, the relative simplicity of the system shown in Fig. 4 is very appealing.

The benefits which can be obtained by combining the steam turbine and the gas turbine, with a supercharged boiler, are so great that they justify the efforts being made to bring this combination to reality. The partial gasification system is a long stride towards this goal, but it omits the very desirable step of pressurizing the steam generator itself.

When the next step is taken, either by direct firing, or by complete gasification, the public utility industry will have at its command a power generating process which will come very close to the best that can be accomplished with means which are today regarded as relatively conventional. To go beyond that, we will need MHD.† THE END

† A complete list of bibliographical references to Mr Yellott's article will be supplied for the asking. Write the Editor, POWER ENGINEERING, 308 E. James St., Barrington, Ill.

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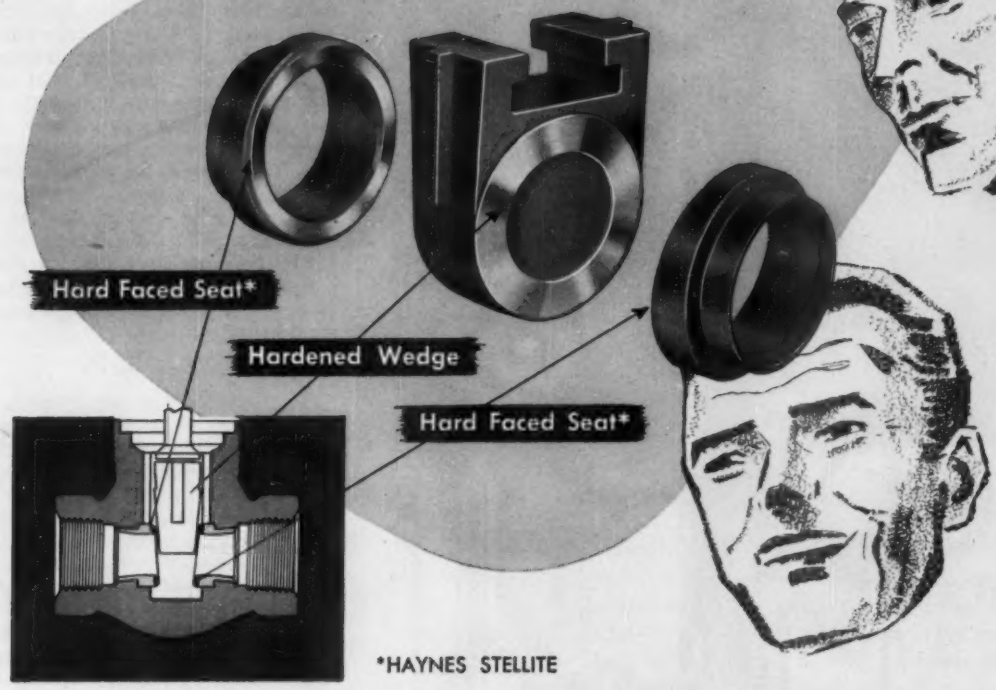

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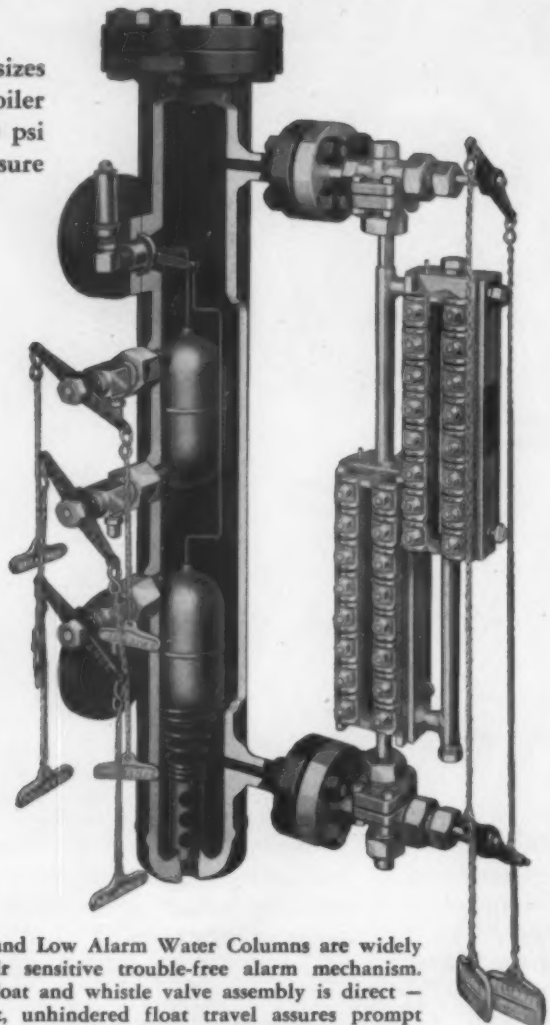

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How a User Standardized Pumps

BECAUSE the centrifugal pump is one of the most widely-used items of equipment in the chemical industry, considerable incentive exists for standardizing these pumps; and in fact an industry-wide standardization program is in progress.

At the plant of Shell Chemical Corporation in Houston, Texas, a plant-wide study was made covering approximately 650 centrifugal pump installations, to consider the adoption of a standard pump for the plant.

Those installations were analyzed to determine the range of head and capacity requirements, and to obtain cost data to serve as the basis for selecting the optimum standard design. This analysis led to the conclusion that the standard pump should be capable of a shut-off head of at least 200 ft and a differential head of 120 ft at a capacity of 250 gpm. Such a pump would handle approximately 80 per cent of the centrifugal pump applications.

Analysis Made

After complete economic analysis, consideration of maintenance costs, desirability of handling all maintenance and repairs in the company's own shop, and other factors, it was decided that the pumps must fulfill the following requirements:

1. The pump should be capable of providing sufficient capacity to meet the performance requirements for at least 80 per cent of the centrifugal pumps in the plant.
2. It must feature maximum dimensional interchangeability both in mounting dimensions and pump parts.
3. It must be simple to remove and install.
4. It should use a minimum number of parts.
5. It must be simple to dismantle and repair under shop conditions.
6. The installed cost should be as low as possible, consistent with maintenance requirements and reliability.

It was decided that a new pump to meet these requirements would be developed as the joint effort of United Centrifugal Pumps and Shell Chemical Corporation.

As reported by R. G. Jobe, in ASME Paper No. 59-A-162 presented before the annual ASME meeting in 1959 at Atlantic City, the pump that resulted is basically a vertical centrifugal pump with an integral electric motor drive. It is designed to withstand piping stresses so that it may

be installed directly in the pipe line, without a base plate or concrete foundation. The author's paper gives a complete description of the physical features of the pump and its driver. The drivers are integral with the pumps and have a plug-type electric power and grounding connection, with a safety interlock to turn off the power in case the plug is removed when the circuit is hot.

A common shaft is used for both pump and motor, permitting interchangeability of drivers and giving a close-coupled design that improves ease of dismantling and gives a rigid shaft with a smaller mechanical seal.

The pump uses a plug-type discharge orifice to modify the performance of the basic unit, and the paper discusses this and shows head capacity curves illustrating the effect of these modifications.

The prototype pump was tested during the latter part of 1957 and installed in January, 1958. Ten additional pumps were installed during the following eight months. There were a few difficulties with the pump seal, and these have been modified, as described in the paper.

Although the new design has only recently emerged from the development stage, some indications of the effects of the design on plant pump costs have resulted. Comparisons show that installed costs, including the price of the pump, were reduced 20 per cent to 35 per cent below that of conventional pumps of cast steel construction.

Good Use of Pumps

In the congested process areas of existing plants, the compact design permits the standard pump to be installed without undue extension of piping or blocking of accessibility to existing equipment. In new construction, the author states that further savings, especially in piping costs, could be made by judicious mounting of pumps on major equipment or on pipeways as is done with motor valves.

The pump has shown no tendency to require undue maintenance. During the six-month period since January 1, 1959, there was only one failure experienced out of 16 pumps in operation. This was a mechanical seal failure due to the presence of abrasive particles. The pump was re-installed with a set of tungsten carbide faces and has since been operating satisfactorily.

Labor requirements to remove and install the new pump are about 25 per cent of that required for the horizontal units. Several complete standard extra pumps are kept in stock for use as replacement, and this

WILL YOUR "GROUNDS" CARRY IT?

During seasons of electrical storms, a careful program of checking all ground connections may save your company serious outages and property damage. Nine tenths of industrial lightning damage is reported to be on vital electrical equipment—motors, generators, transformers. Experience shows that ground resistance does not remain constant. Tests should be made at least once a year, and high ground resistance corrected.

Do You Have This Information File on Grounding?

The James G. Biddle Co. File 25 is an excellent fund of information on grounding problems. It includes a Manual on Ground Resistance Testing, and Bulletins on "Grounding Electric Circuits Effectively" and "Grounding Principles and Practices Applied to Industrial Plants."

USE THE MEGGER® GROUND TESTER

To test ground connections, the easiest, quickest, and most dependable method is the use of the Megger Ground Tester with its own hand generator for current supply. Reading the resistance value is as easy as reading a voltmeter—directly in ohms. Only *one set of connections, one operation, without any calculations.* Each instrument is self-contained, rugged, and portable. Its cost is a small fraction of the savings resulting from adequate grounding protection.

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B1010

BIDDLE INSTRUMENTS

JAMES G. BIDDLE CO.

Electrical & Speed Measuring Instruments

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For more data circle 554 on Post Card

SARCO TOPICS

How correct strainer selection protects equipment, maintains fluid flow, and prevents shut-downs

Strainers for wash water for power plant condensers cleaned without shut down

Sarco Type VRS Rotary Scraper Strainers enable operators to clear the screens with a few turns of the crank, without shutting down the line or dismantling the strainer.

Sizable quantities of water are required for cleaning condenser water screens at a power plant in California. Sea water is pumped for the purpose and must be freed from debris and sea life such as mussels and sardines. Further, any screening devices used must be capable of cleaning without shut-down.

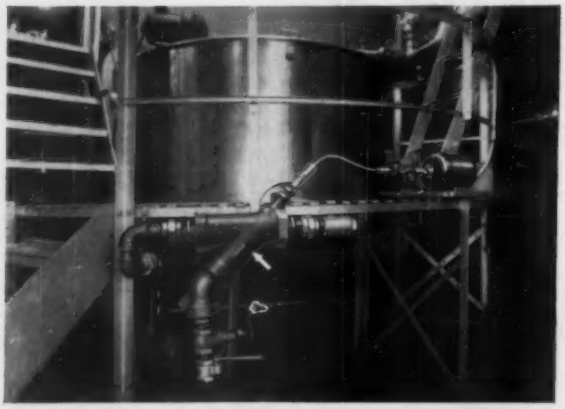
These problems were met by installing two Sarco type VRS scraper strainers ahead of the wash water pumps. This type of strainer is cleaned by rotating a spiral blade either manually or by motor drive. Motor-operated rotary-type strainers make it possible to clean the strainer continuously. The blade scrapes the screen clear, and collected solids are blown down from the strainer as required. Clean screens minimize pressure drop. The Sarco strainer installation has materially reduced maintenance hours and insured against temporary shut-down caused by clogged strainers.

Helical scraper knife clears screen without shutdown in East Chicago Air Conditioning System

Offices of the Inland Steel Company, at East Chicago, Indiana, are cooled with air conditioning units of 7½ tons and larger. Water for condenser cooling is pumped in from Lake Michigan.

Although passing through traveling screens, the incoming water still contained fine sand which clogged the screens. Frequent cleaning was required, and every now and again the units were practically out of service.

Plant engineers found their answer in Sarco Rotary Scraper Strainers, Type VRS. These units incorporate a hand-operated helical scraper knife within the cylindrical strainer screen. These scrapers made it possible to keep the strainers clean simply by cranking the scraper a few turns at regular intervals. Sand scraped off the screen is blown clear and discharged at pressure through a manually operated valve to waste. Now it is not necessary either to dismantle the strainer or shut down the unit.



IN PROCESS APPLICATION This Sarco motor operated-Scraper Strainer, Type SRS, is used to strain chocolate syrup in a processing application, providing continuous flow of fluid without shut-down for maintenance. 2167

For information on Sarco strainers, contact your Sarco sales representative, district office, or distributor; or write—

SARCO

SARCO COMPANY, INC.
635 MADISON AVENUE, NEW YORK 22, N. Y.
PLANT: BETHLEHEM, PA.
STEAM TRAPS • TEMPERATURE CONTROLLERS
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will reduce the amount of emergency repair work. Although a service time of only one year has been available to establish comparative maintenance costs, experience to date shows the maintenance cost to be 15 to 25 per cent less than that for comparable horizontal pumps.

MORE ABOUT —

Flame-Ceramics

Continued from page 98

ing applied to the rollers for the silicon steel normalizing furnaces. The thirteen-foot rolls are being coated automatically, three at a time, after having been grit-blasted.

Other applications are progressing, foremost among them the already-mentioned coating of piston crowns, valves, and cylinderheads for diesels. Other work in progress includes:

1. Coating the pistonheads of a Nordberg diesel power plant engine; the pistonheads alone weigh over 600 lbs.

2. Pistons, cylinderheads, and valves of automotive diesel engines are to be coated.

3. Flame-Ceramic coatings have been applied to the heads and pistons of an Ingersoll-Rand Gas Engine; to the pistons, heads, and valves of a Baldwin Model 600 locomotive engine; and to the pistons, heads, and valves of a 12-cylinder ALCO engine.

4. The gasoline-engine field is being developed. We have completed the coating of the pistons for a contemporary sports car; these are soon to be installed, and the detailed working data submitted for examination. Armour Research Institute of Illinois Institute of Technology, which originally developed the Flame-Ceramic process, has conducted interesting experiments in this area.

5. Tow-boat diesels are being coated — valves, pistons, and cylinderheads.

Potential of Flame-Ceramics

Possibilities of Flame-Ceramic coatings appear to be almost unlimited. With some 2,400,000 diesel and gas engines in use in this country today, the potential savings in fuel, lubrication, maintenance, and life of engine parts could have an important affect on the economy.

Editor's note: As temperatures increase, in some of the newer power field developments, it would appear that Flame-Ceramics might be the answer to some of our current problems. THE END

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Just write the Editor, 308 E. James St., Barrington, Ill.

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help prevent shutdowns
HANDLE ALL MEDIA
condensate, steam, water, oil, and other piped fluids
PROTECT ALL EQUIPMENT
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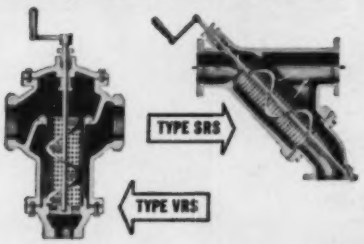
hand operated and motorized



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NEW! TYPE CT CAST STEEL. SPECIFICATION A.S.T.M. — A-216 Gr. WCB
SARCO
Tensile strength 70,000 lbs. per square inch minimum; for saturated steam or liquids to 600 psi, non-shock and 750° F. total temperature.

Also Sarco Y-Type strainers in cast iron, brass, and semi-steel, screwed and flanged, all sizes and pressures.

For information on Sarco strainers, contact your Sarco sales representative, district office, or distributor; or write— 2166

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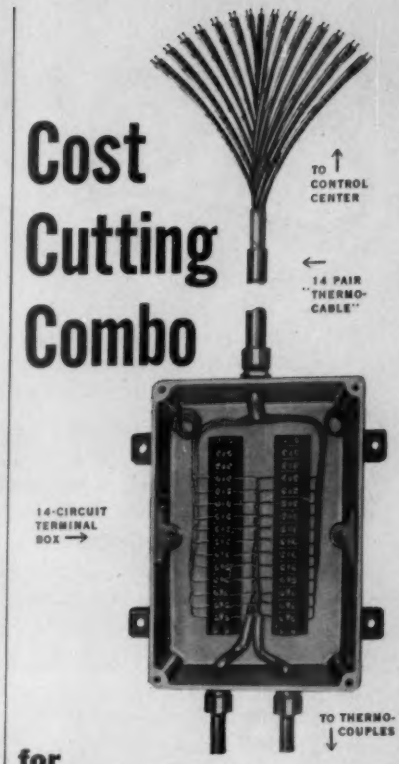
Cost Cutting Combo



for
Thermocouple Extension Wire Installations

Here's an economy team to increase efficiency and cut costs up to 75% in your next thermocouple extension wire installation. Multi-conductor "Thermo-cable" permits you to install from 6 to 56 pairs of color-coded, insulated thermocouple leads, at one time, using just one cable. Terminate the wires in a weatherproof multi-terminal box specifically designed for "Thermo-cable".

No more pulling individual leads through conduit. And, "Thermo-cable", with its polyvinyl chloride weatherproof, heat and corrosion resisting outer sheath often eliminates the need for conduit. Direct burial types available to eliminate hazards from fire and mechanical damage.

T.E. weatherproof Terminal Boxes are made of cast iron or sheet steel, can accommodate from 6 to 100 circuits, and offer sure protection against the effects of contaminating atmospheres. Made to N.E.M.A. or JIC specifications.

Write today for Catalog 21.

Thermo Electric CO., INC.
SADDLE BROOK, NEW JERSEY

In Canada: THERMO ELECTRIC (Canada) LTD., Brampton, Ont.

For more data circle 556 on Post Card

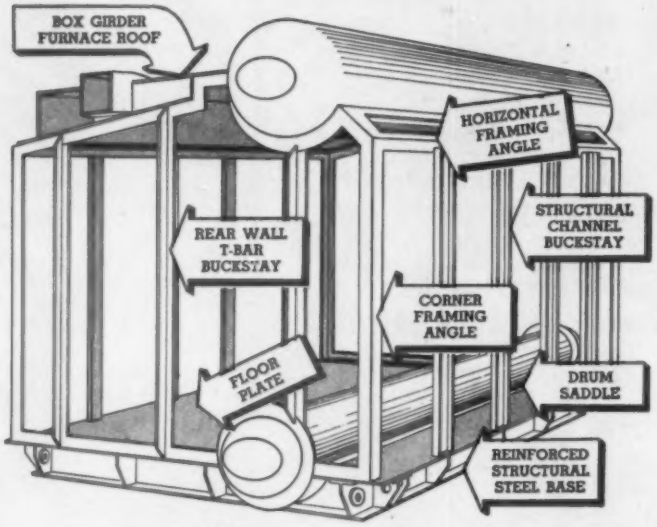
SUPERIOR'S Rugged Framing and Heavy Casing PREVENT Bulged Casings and Gas Leakage

Of the exclusive features incorporated in every Superior Packaged Water Tube Boiler . . . two of the most important are its heavy gauge casing and structural steel framing.

Because water tube packaged boilers have positive pressure furnaces, their outer casings must be welded to prevent gas leakage. But welded casings without reinforcing do not provide sufficient strength to resist the stresses of movement resulting from expansion . . . which causes thin casings to break at the welds, and permits gas to escape.

To eliminate the problem, Superior Packaged Boilers are built within a structural steel frame and covered with casings of heavy steel of sufficient thickness to permit heavy welded joints to structural members.

Only Superior Packaged Boilers provide 10-gauge steel casing reinforced with 4" channel iron buckstays every 24" and casings welded to both legs of the channel.



All this without sacrificing accessibility . . . note in the photo below the inspection openings at top and bottom of every side panel.

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HELPFUL BULLETINS

continued from page 32

144 Gas Turbines for Peaking — Peaking combustion gas turbines with capacities ranging from 7,000 to 28,000 kw are described in 12-pp Bulletin GED-3761. Outlines savings possible through lower installed costs, minimum space and personnel requirements, less transmission equipment investment, lower line losses, and lower standby when combustion gas turbines are installed for electric peaking. General Electric Co.

ELECTRICAL

145 L-V Distribution Equipment — Now available, the 84-pp, 1960 Buy Log covers low-voltage distribution equipment. It serves as a condensed buying catalog for service entrance equipment, light and heavy duty safety switches, tumble and open-knife switches, hinged wireway, circuit breakers, switchboards, motor control centers, sectional distribution centers, panelboards and busway. Among features provided in this easy-to-use catalog are selector charts, pictorial descriptions, consolidated pricing tables. General Electric Co.

146 Transformers for All Services — Bulletin 139 illustrates and describes principal types of company's line of transformers. These include ventilated dry-type transformers, power transformers, inert gas sealed dry type transformers, ventilated dry type unit substation transformer core and coil assemblies, specialty dry type lighting transformers, network transformers, station type transformers, pole type distribution transformers, others. Niagara Transformer Corp.

147 Highway Type Mobiles — Bulletin GEA-4415C, 24 pp, provides technical information on mobile substations rated up to 20,000 kva, 115 kv, and mobile transformers rated up to 40,000 kva, 138 kv. The transformers are used as spare units for quick restoration of service in emergencies. The mobile substations are normally used to by-pass regular substations when maintenance is required. Bulletin presents new product features, application information, tables, outline drawings, price data. General Electric Co.

148 Submersible Pump Motors — Eight-pp Bulletin F-2000 contains full-length cutaway drawings showing construction details of features of submersible motors for 6-, 10- and 14-in. well diameters and explains their water-filled operating principle. Also presents exploded and assembled views of the motors' thrust bearing. Includes ratings for submersibles from 5 to 300 hp. U. S. Electrical Motors Inc.

149 Magnetic Motor Controls — Six-pp Form A-262 describes design principle and operating features of company's magnetic motor controls. Typical applications showing how units are packing more control into less space are covered. Arrow-Hart & Hegeman Electric Co.

150 Guide to Relays — Illustrated Bulletin 7021, 12 pp, discusses relays for all applications. Relays included are general purpose, mechanically held (latched-in), pneumatic time-delay and synchronous motor-driven timing, others. Brochure

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contains relay descriptions and application and installation details as well as dimensions, ratings and ordering information. General Electric Co.

151 A-C Magnetic Starters — Engineering data on a-c magnetic starters is presented in 8-pp Bulletin PL 12–8–160. Discusses arc quenching principle which provides greater contact life, other features and details. The Clark Controller Co.

152 Air Conditioning Starters — Bulletin 8630, 8-pp, describes starters for central air conditioning applications. Detailed information on full voltage, reduced-voltage, auto-transformer and wye-delta starters in ratings ranging from 208 to 4900 v., and electrical characteristics given. EC&M Div., Square D Co.

153 Contactors, Starters — Twenty-pp Bulletin GEA-7020 contains information on magnetic contactors and starters including combination, reversing and two-speed forms, and modification kits available. Gives application, installation and maintenance information along with product features. Construction details, including photos and description of sub-assemblies, are also pointed out. General Electric Co.

155 Testing Instruments — Twelve-pp Bulletin 19–60 contains descriptive information on company's line of instruments for industry, including electrical resistance testers, dielectric test sets, cable fault locating equipment, turn ratio test sets, and others. Advantages are detailed. James G. Biddle Co.

156 Portable Test Units — Presented in this 48-pp bulletin is detailed information on portable test units for protective relays. Subjects treated include classification of relay tests; preparation for protective relay testing; reasons for an adequate testing and maintenance program; tips on tester selection. How the test units can aid in relay functioning is discussed. Provides specifications for standard and special units. Multi-Amp Div., Multi-Amp Electronic Corp.

157 High Voltage Bushings — Bulletin 546, 28 pp., lists apparatus bushings for transformer, circuit breaker and special purpose applications in a choice of types, sizes and ratings. Featured are POC (paper-oil-condenser) and POC-A (paper-oil-condenser-adaptable) lines of condenser type, oil filled transformer and circuit breaker bushings, 15–230 kv. Also presented are cover type bushings, sidewall, network, high current, corona free, high altitude, solder-seal and wall, floor and roof types. Lapp Insulator Co., Inc.

159 Mineral Insulated Cable — Properties and applications of mineral insulated cable, including hazardous area applications, are detailed in this 16-pp bulletin. Includes specifications, installation data, lists construction and performance characteristics. General Cable Corp.

160 Portable Cords, Cables — Specifications and characteristics of various portable cords and cables are presented in this 52-pp bulletin. Gives pertinent data on insulation compounds and jacket compounds, and includes tables giving properties of 600 v portable cables, from single to four conductor, also single to four conductor 601–5000 v portable cables, and others. A section is devoted to methods for splicing and patching portable cables. Kaiser Aluminum & Chemical Sales, Inc.

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- Minimum Pressure Drop
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- Valves that cannot wedge or jam
- Self-grinding rotating disc

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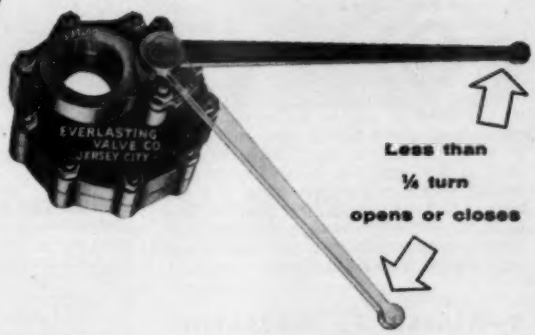

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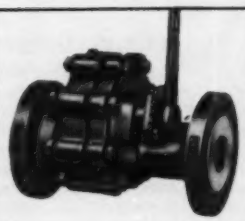

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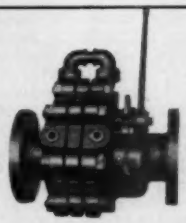

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EQUIPMENT NEWS

Described on these pages are new and improved products. Use Reader Service Cards on pages 119–120 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

1—ELECTRIC RECEIVER uses remote transmission

All electric and electronic operation of Model 731 permits great speed of response, company says, in remote indication of gas and liquid pressure, draft, differential pressure, flow, temperature, and liquid level. By utilizing remote electric transmission, danger of high pressure and temperature lines at panel boards is eliminated, it is claimed, and impulse piping requirements reduced to the short length needed between point of measurement and transmitter. A three-wire transmission line is all that is required between transmitter and receiver. A plug-in connector to amplifier is its only external connection. Power supply to amplifier is 115 v, 60 cycle, single phase, a-c, with a power consumption of 50 w. Sensitivity is described as 0.1 per cent of full range or better, with calibrated accuracy for flow being ± 1 per cent of full range scale. For low, medium or high pressure, and temperature, calibrated accuracy is ± 2 per cent of full scale range. The Hays Corp.

2—ASBESTOS INSULATION wraps on to protect piping

Insutape is described as a wrap-on asbestos insulation that is both flameproof and weatherproof, intended for industrial applications requiring an easy-to-apply, economical insulating material. Manufacturer says it is especially adaptable to insulating work under difficult application conditions — in close-clearance spots, and for bent or curved instrument lines and pipe. It can be removed and reapplied. Insutape consists of long-fibered asbestos rovings, enclosed in a tubular, woven asbestos jacket. Exposed surfaces and edges are Neoprene coated to provide a tough, abrasion-resistant covering essentially non-combustible as well as resistant to penetration of moisture, oil and grease. Fibrous Products Div., Union Asbestos & Rubber Co.

4—CORROSION INHIBITOR comes in flake form

Super-Filmeen Flake is a filming amine corrosion inhibitor in flake form, described as completely active and containing no additives. The flake is easily weighed and dispersed in water for the feed solution, manufacturer says, and not subject to dehydration at high temperatures encountered in superheated steam. It is alkaline in the feed solution, relatively non-corrosive to chemical feed systems, and can be mixed in mild steel equipment. Product consists of a drum-dried blend of octadecylamine and a filming amine emulsifier. It has a melting point of 115 to 120 F. Dearborn Chemical Co.

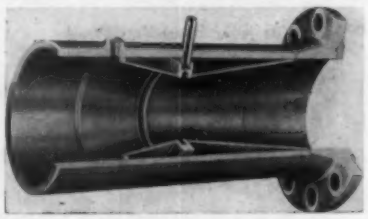
5—A-C MOTOR has built-in overload protection

Thermo-Tector, a simple and fast-acting protective feature, is available on this company's Tri-Clad '55 three-phase induction motors to 125 hp, frame sizes 254U to 445U, in any installation class or enclosure. Protection is provided by two or more miniature heat-sensing switches buried in the stator windings. The switches, connected in series with conventional motor control, serve to shut the motor off whenever internal winding temperature exceeds a predetermined amount, regardless of rate of temperature rise. The Thermo-Tector system uses only two additional wires.

Several advantages are claimed for Thermo-Tector. First, burnouts from overload are practically impossible; the heat-sensing switches "keep a finger on the motor pulse" under the coil insulation. Second, manufacturers of driven equipment can match the drive motor more closely to the load, without need for a higher power rating as a safety margin. Control devices relays and amplifying circuits aren't needed, company adds, and the system is "fail safe" as any break in wires, switches, etc. stops the motor. General Electric Co.

6—DALL FLOW TUBE in weldment-type design

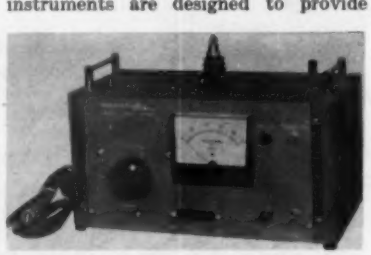
The Weldment-Type Dall Flow Tube has been developed for metering petroleum, chemicals, gases or other process fluids at low or high pressures and temperatures. A variety of metals in the



form of rolled steel plate, castings, forgings and bar stock can now be used. Thus, combined advantages of power savings from low head loss, accuracy and short laying length can be offered in metals suited for a specific flow metering application, company says. Available in line sizes from 1 to 120 in., the intermediate and larger tubes (from 8 in. up) are strong weldments of rolled or forged sections. Smaller tubes are machined from castings or from bar stock. B-I-F Industries, Inc.

7—A-C DIELECTRIC SET tests larger motors, equipment

Included in the line of Hywatt Hypots, portable a-c dielectric testers in bench-type cabinets, are eight models with outputs from 1500 v a-c at 0.5 kva to 10,000 v a-c at 1.0 kva, continuous duty ratings. Intermittent ratings are approximately twice continuous ratings. These instruments are designed to provide



economical a-c dielectric test facilities where high output current is required for breakdown testing electrical equipment, such as motors rated from 2 hp upwards, long sections of insulated wire, transformers, and capacitance loads with high charging currents.

Output voltage is continuously adjustable from zero to maximum, with a 4½-in. rectifier kilovoltmeter connected directly across the high voltage output. Thus, it is noted, actual applied test voltage is indicated, irrespective of regulation. A fast-acting magnetic circuit breaker, with manual reset, operates

3—PILLOW BLOCK designed for easy liner replacement

Bronze precision liners can be replaced easily in these pillow blocks, it is announced. The new sleeve bearings are suggested for use where shock loads, elevated temperatures and corrosive conditions are anticipated. It is possible to replace a worn bushing, or liner, without removing the bottom half of the housing from its support, company states; only the cap of the block is removed — the shaft being lifted just enough to let the lower half of the liner be loosened and slipped out. A new bronze liner can then be inserted and seated by tapping lightly. The cap liner is also replaceable. No screws are required. A brass retainer spool between cap and base of housing serves to prevent rotation of liner with shaft.

The new bronze-bushed line includes split journal bearings (two-bolt) for standard power transmission shaft sizes from 1 15/16 to 2 15/16 in.; rigid pillow blocks (four bolt) for shafts from 3 7/16 to 8 in., and angle pillow blocks for standard transmission shafts. For heavy-duty service, these bronze-lined blocks are designed to withstand high temperatures, relatively high shaft speeds, shock and pressure. Dodge Mfg. Corp.

A Nalco PRODUCT MANAGER

Answers Questions about Steam Condensate Systems Corrosion . . . and How to Control It

Costs of Equipment Repair and Replacement Can Be Cut Drastically with a Sound Control Program

Industry still pays a huge annual bill for down-time, equipment replacement and repairs made necessary by steam condensate corrosion. Much of this cost can be eliminated by knowledge of what the problem is and action toward solving it. Here are answers to some basic questions that may be helpful to you.

Question: What does corrosion do in a steam condensate system?

Answer: Corrosion literally eats up the metal in the system from the inside. Piping, valves, pumps, and process equipment can be seriously damaged or ruined by corrosive condensate. Even boilers can be damaged by deposits resulting from metal oxides in corrosive returned condensate.

Question: What causes steam condensate corrosion?

Answer: Most condensate system corrosion is caused by carbon dioxide and oxygen, carried into the system with the steam. Carbon dioxide, dissolved in the pure condensed steam, forms corrosive carbonic acid. If oxygen is present with carbon dioxide, the corrosion rate is much higher, and is likely to produce localized pitting. Ammonia, in combination with carbon dioxide or oxygen, attacks copper alloys.

Question: What constitutes a corrosion prevention program?

Answer: There are three factors which should be examined in setting up a condensate corrosion-prevention program:

a. Softening, or other pretreatment of boiler feedwater should be designed to reduce the quantity of potential carbon dioxide that can be released from the boiler. Effective deaeration of feedwater also helps reduce oxygen content. Attention to both of these will make the final condensate corrosion prevention treatment more economical.

b. Mechanical design of the system should include such factors as maximum venting of corrosive gases, adequate velocities in lines, proper installation and maintenance of traps, and elimination of severe steam-impingement.

c. An effective chemical treatment program should be set up. Treatment may be either with a volatile amine chemical to neutralize carbon dioxide, or with a filming inhibitor which forms a protective barrier between the metal and the corrosive condensate.

Another important part of the chemical treatment program is continuous application of a fast acting chemical oxygen scavenger to the boiler feedwater.

Question: Can Nalco provide recommendations for a complete condensate control program?

Answer: Yes. Nalco will make a thorough survey and make recommendations for a complete corrosion control program.

Question: Which type of chemical treatment is best: volatile neutralizing amine or filming inhibitor?

Answer: This depends on the system to be treated. Plant layout and operating conditions, and the characteristics of boiler feedwater are some of the factors which should be taken into consideration. Generally,

James M. Seamon, Manager
Nalco Power Industry Chemicals Department

volatile amines are most desirable where low make-up volume, low feedwater alkalinity and good oxygen control exist. Filming inhibitors usually provide most economical protection in systems with high make-up, oxygen in-leakage, high alkalinity, or where the system is operated intermittently. In some plants, a combination of protective chemicals may be needed.

This is the area where Nalco know-how can result in thorough protection at minimum cost, by recommending a specific program to fit individual plant conditions.

Question: Isn't one condensate corrosion control chemical about the same as any other?

Answer: Definitely not. Both the volatile amines and filming inhibitors are complex chemicals—members of chemical "families" in which a nearly infinite variety of types is possible. Best treatment chemicals are those which offer the greatest protection in relation to their cost. Even though Nalco chemicals are now outstanding in results-per-dollar, Nalco research and development continues in order to improve this ratio.

Question: What help can Nalco provide in setting up and maintaining a condensate corrosion control program?

Answer: Your Nalco Representative has the technical training and experience to be of substantial assistance in setting up and maintaining an effective condensate corrosion control program. His service is backed by the facilities and experience of the entire Nalco organization. Where special problems occur, Nalco specialists are ready to help him find answers promptly.

Suggestion: Call your Nalco Representative, or write to me for further details on Nalco steam condensate corrosion control . . . or data on any aspect of modern water treating practices for better plant operating efficiency. James M. Seamon, Manager, Power Industry Chemicals Department.

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when full kva rating is reached. Panel and cabinet are grounded. Operation is from 115-v, single phase 50-60 cycles a-c. Associated Research, Inc.

8—MODULAR SWITCHBOARD meets requirements to 5000 amp

The VFS Distribution Switchboard is a modular one designed to meet operating requirements up through 5000 amp with quick-make, quick-break action. Using company's QMQB switches for applications to 1200 amp and SP-1 Service Protectors for those through 5000 amp, these switchboards are offered especially

for use where service needs range from 600 through 5000 amp, 250 and 600 v. They handle not only heavy continuous currents, manufacturer states, but also give fault protection on short circuits to 200,000 amp.

Because modular design, switches can be added, replaced or interchanged in minutes; also inspection under operating conditions has been made easy — front removal can be achieved without disturbing bus or adjacent units. Safe handling by semi-skilled personnel is also claimed, due to such built-in safety features as arc quenchers to control and eliminate dangerous and prolonged arcing; load-break devices on all switches to permit their being opened or closed or closing under operating or even fault conditions; and external front-operated handles. Steel enclosures protect operator. Federal Pacific Electric Co.

9—TEFLON-LINED HOSE stands chemicals, cleans easy

Flexlon withstands all known chemicals except fluorine gas, chlorine trifluoride, and molten alkali metals, according to manufacturer, and has low permeability and zero water absorption. Since nothing sticks to the waxy Teflon tube, cleaning and sterilization are easy, company points out, and the hose is flexible and easily handled. Flexlon's construction features a bonding of the glossy Teflon tube to the hose body, which is said to eliminate separation, cracking or splitting — even with small radii. Plies of high tensile cotton cords or braided steel wire (depending on pressure or temperature), form the strength members, bonded to tube and cover.

Flexlon is suggested for flexible connections in process equipment handling corrosives, caking slurries or solvents, and for conveying pharmaceuticals, foodstuffs and other fluids requiring sterilization and easy cleaning. Temperatures to 325 F and working pressures to 1500 psi are reported acceptable, depending on size and type of hose. It is available in diameters to 1¼ in., 15- to 50-ft lengths. Manhattan Rubber Div., Raybestos-Manhattan, Inc.

10—LOW-DOWN MOTOR BASE designed for crowded areas

For variable-speed sheave installations where space is at a premium, this sliding motor base is of the low pancake type. A feature of Quick Slide Base is an adjusting screw — it can be moved quickly and easily to shorten center-to-center distance and free V-belts from grooves for sheave adjustment, manufacturer claims. Height of the Quick-Slide is only 1 5/16 or 1 21/32 in. and amount of movement 4½ or 6 in. (both depending on NEMA motor frame number); bases with 9-in. movement can be ordered. The top plate of the motor base is drilled to accommodate various combinations of NEMA motor frames. The base may be used with any V-belt drives, but is designed for use with variable-speed drives where it is necessary to vary the center distance between sheaves with pitch-diameter changes. T. B. Wood's Sons Co.

11—ALUMINUM LUBRICANT eases conduit installation

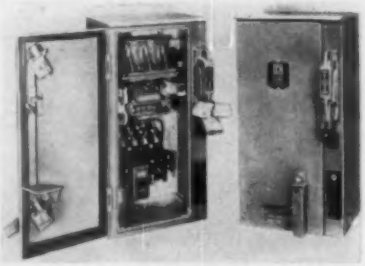
Penetrox is an aluminum conduit lubricant claimed to make the conduit easier to install and to protect the joints. It's packaged in 8-oz polyethylene squeeze bottles and a light application does it, according to manufacturer — the lubricant lasting the life of the joint and facilitating loosening it for change-outs. Penetrox also serves to moisture-seal joints against dampness, to prevent galvanic corrosion of aluminum-to-steel joints in damp locations. Burndy Corp.

12—FUEL ECONOMIZER reduces smoke and fuel cost

The Farris Fuel Economizer is reported capable of saving up to 25 per cent of fuel cost, and minimizing smoke. The unit injects preheated secondary air (up to 700 F) over the furnace or boiler fire creating a hotter fire that results in more complete combustion of fuel and a minimum of waste products. It mounts inside furnace or boiler fire door, does not require any fuel, power or maintenance and can be used with high or low pressure boilers firing oil, coal or coke. Farris Combustion Controls Corp.

13—COMBINATION STARTERS provide extra safety

New disconnect-switch and door-closing mechanisms have been incorporated in these combination starters to provide extra safety for personnel. Disconnect



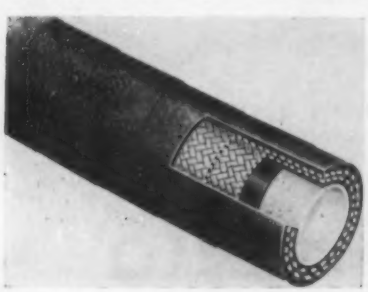
handle is permanently attached to switch to eliminate false indication of switch position when door is open. Handle is always in control of switch, regardless of whether door is open or closed, and door cannot be opened with switch on, company says, unless a bypass is operated. Switch cannot be operated unless door is latched and sealed. No tool is required to seal door, but it can only be opened with screwdriver. Fuse clips are interchangeable, and can be spaced to accommodate either 250- or 600-v fuses. Bulletin SM-292 gives details. Square D Co.

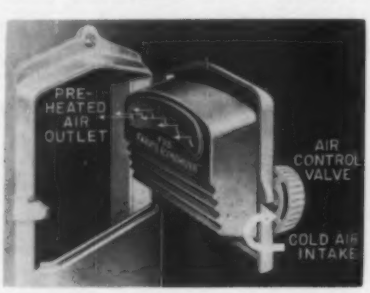
14—CONTROL VALVES, single seated, high capacity

The 2000 series of single seated control valves features high capacity, ability to handle high pressures and pressure drops, and a wide selection of reduced capacity trim, it is announced. Design incorporates a top guided, unrestricted seat-ring area with body and plug contours providing greater capacity. In addition, high capacity is attained with minimum seat ring areas, company notes, resulting in less unbalance force, permitting higher pressure drops. Available in sizes from ¾ to 10 in. with ratings in iron of class 125 or 250 ASA, and in steel from 150 to 2500 lb ASA. Mason-Neilan, Div. Worthington Corp.

15—ELECTRIC VIBRATOR moves stubborn materials along

The RC-32 is announced as an explosion proof electric vibrator for moving stubborn materials through bins, chutes and hoppers. Because unit uses no pulleys, belts or springs, company claims its operation is practically noiseless and maintenance is minimal. It delivers 3600 vibrations per minute with 60-cycle current. Vibration force is produced by eccentric weights fastened on each end of rotating motor shaft. You can adjust





Madison, Wisconsin Plant of Oscar Mayer & Co.

New Detroit RotoGrate Stoker for Oscar Mayer & Co.'s Madison Plant to develop 125,000 pounds of steam per hour continuously for 24 hours—150,000 pounds for peaks, when burning Indiana coal, 10530 BTU per pound, 13.25% ash, A. F. T. 1900° F. Helmick and Lutz, Minneapolis, Consulting Engineers.

Since 1938

Detroit Stokers have served Famous Sausage Makers with Economy . . . High Availability . . . Low Maintenance

Oscar Mayer & Co., pioneer meat processing firm, has been making sausages since 1883. By stressing quality and uniformity of product, it has grown from a small meat market on the near-north side of Chicago to the nation's 9th largest producer with sales last year of $260,000,000.

In 1938, the company installed a Detroit RotoStoker in the Madison, Wisconsin, plant. Purchase of a plant in Davenport, Iowa, brought them another RotoStoker in 1941.

These served so well that in 1947, they bought a Detroit RotoGrate Stoker for the Madison plant as a part of an expansion program.

When more expansion was planned in 1959, they bought two more RotoGrates, one each for the Madison and Davenport plants, making a total of five acquired since 1938.

Detroit RotoGrate is an overthrow spreader stoker with traveling grates that move slowly forward, discharging ash at the front. Suitable for boilers up to 400,000 pounds of steam per hour capacity . . . it burns any bituminous coal or lignite and many types of refuse, separately or in combination with coal. It is one of the complete line of Detroit Stokers for small, medium and large boilers.

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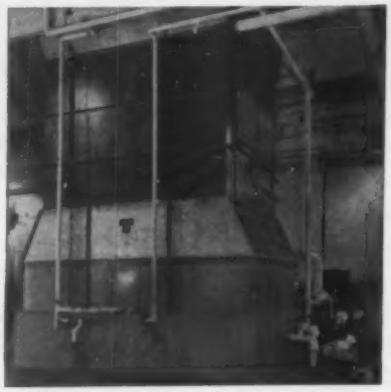

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vibration impact from 385 to 1100 lb. Vibrator is available in three phase, a-c current, 220 or 440 v, with 500 w input. The Cleveland Vibrator Co.

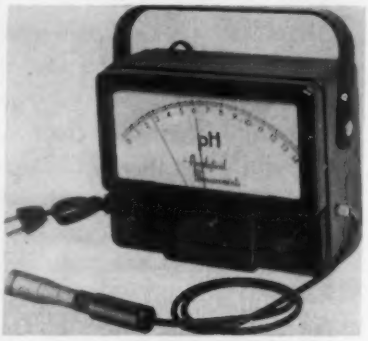
16—TERMINAL ASSEMBLY for easy brush replacement

This quick-disconnect terminal assembly is designed to facilitate brush replacement on electric utility equipment,

and on any motor or generator in which brushes are difficult to reach. Assembly consists of a stationary clip easily bolted to the machine, into which either one or two terminals can be easily snapped. National Carbon Co., Div. Union Carbide Corp.

17—PORTABLE pH METER has an extra large scale

Model 700 Big Scale pH Meter is designed for easy reading of pH values within 0.02 pH. Weighing only 5 lb, it can be used wherever a standard 115-v



a-c outlet is available. It features a single operating control and a high output, electronically modulated amplifier, with printed circuitry and sensitive meter elimination. Polyethylene electrode probe unit permits use anywhere on production line. Price of Model 700, with probe unit, solutions is under $150. Analytical Measurements, Inc.

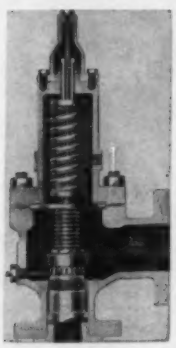
18—PRODUCT RECORDER can perform multiple measurements

For watt or kilowatt recording and for multiple measurements, such as weight times speed and flow times density, Model 6717 houses two independent measuring systems within a single case. Employing two electronic amplifiers, this compact recorder operates on a null balance principle. Two independent millivolt signals are connected to the

individual inputs. The signals are multiplied and the product recorded. Multiplying is accomplished through use of a retransmitting slidewire on one measuring circuit wired to the input of the second measuring circuit. Range of the two measuring circuits can be rapidly changed, permitting use of replaceable range standards. Standard carriage speed across full scale is 2 sec. Chart speeds provide a range of 1 in. per hour, to ½ in. per minute and speeds can be changed quickly. Alarm switches are available for each measuring circuit. Weston Instruments Div., Daystrom, Inc.

19—BELLOWS RELIEF VALVE designed for vapor service

Series DB Valves are bellows units designed to keep corrosive and viscous fluids away from working parts and provide a balancing action against a variable back pressure.

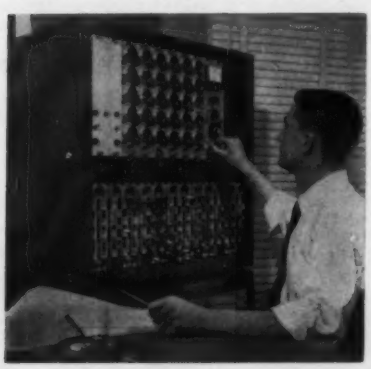


Foremost among features announced is a Saf-T-Alarm to warn of bellows rupture; it can be self-contained or furnished for remote control. Interchangeability with conventional one-ring valves is another feature. Also, the cap arrangement of this valve provides a bolted cap as standard and is interchangeable with a packed cap. The cap contains provision for gagging without taking the valve out of service. The knockout nozzle, designed for easy replacement, can be slipped out of the valve when the holding nut is split.

Other advantages noted by manufacturer include two seating surfaces in one disc, and substantial cost reductions afforded by use of PVC trim where pressure-temperature conditions allow. Bulletin V-100/60 gives details. J. E. Lonergan Co.

20—ANALOG COMPUTER is economical, desktop model

About the size of a television set, in its basic model, and priced to sell as low as $2000, this analog computer is designed to expand. Because it is built on a modular system, more complex components can be added as requirements dictate. However, even after necessary components have been added, the unit's cost will still remain less than half that of



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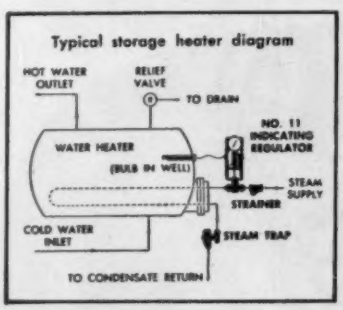

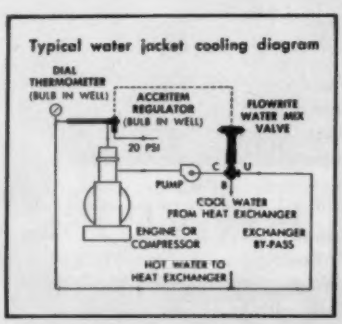

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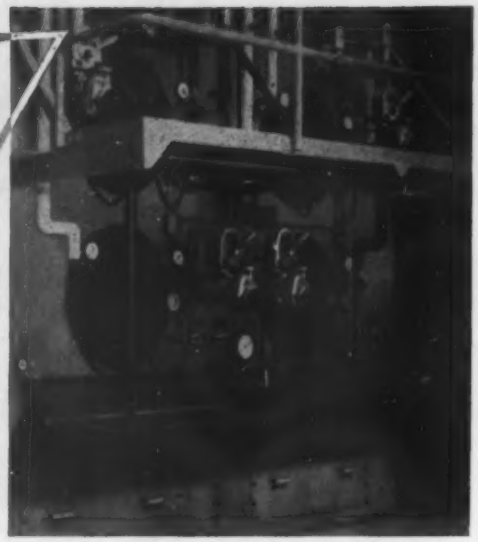

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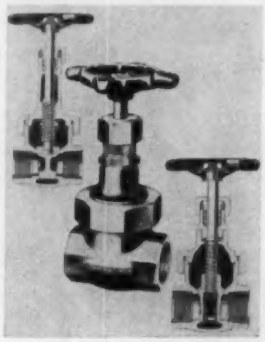
most console equipment, according to manufacturer. It is pointed out that by expanding the basic unit to a complex floor model, at a cost of about $25,000, a plant can add such components as a pre-programmed, removable patchboard system, up to 64 amplifiers, electronic multipliers and diode function generators — all requiring less power than a toaster. Bowmar Instrument Corp.

21—GATE VALVES offer safety, maintenance benefits

Bronze gate valves in this series contain built-in safety features and performance characteristics designed to make them especially suited for the 125 to 150 psi steam-pressure range. Maintenance and safety advantages are attributed to three design elements: union bonnet,



reinforced body, and cylindrical body neck section. Also, the chamfered opening inside the top of the body provides more working room for positioning the discs on the guide when assembling the valves. Long pipe threads in the valve body serve to permit tight valve-to-pipe jointing, without risk of pipe crowding and disc distortion.

One valve in the series, Figure 3125, has double disc and rising stem. Figure 3127, with solid wedge disc and rising stem is suggested for food processing services and lines handling gummy and tacky substances. Figure 3129, with single-wedge disc and non-rising stem, is for installation where overhead space limitations rule out use of a rising-stem type valve. Lunkenheimer Co.

22—AUTOMATIC DEGAUSSER for reeled magnetic tape

Type 5-055A Automatic Tape Degausser is for use with ¼- to 2-in. wide tapes, 7- to 14-in. diam reels, and hubs of all dimensions. A reel of instrumentation tape recorded to saturation is erased to at least 50 db below normal record level, it is stated; uniform degaussing is

achieved with automatic time cycling of reels in the magnetic field. After a reel of tape is placed on the turntable spindle and the button pressed, capacitor-type motors slowly move the reel into the erasing field, rotate it several times, and slowly withdraw it. When the reel returns to position, the degausser shuts off. The cycle takes about a minute. Heavy-duty coils excited by 117-v 60-cycle current provide the erasing field. The degausser weighs about 80 lb, is shielded to prevent erasing field radiation from reaching nearby tape system components. It is suitable for bench-top use, or mounting in racks or cabinets. Consolidated Electrodynamics Corp.

23—WOODEN LADDER with extra safety advantages

Outstanding feature of the Surefoot is an automatic self-leveling device — a coil spring within a rugged aluminum tube. The spring serves to automatically adjust the legs to uneven terrain. Once the ladder is set and the legs have compensated for the uneven ground, the bottom rung automatically sets a pin-lock

when the first step is taken, it is explained, and the ladder remains set until the pin's ring is pulled. Three optional foot pads are offered for the leveling device: a hard, rough rubber for normal use, a single large spike or multiple cleats for use on snow or ice.

Another safety and performance feature is a sling attachment fitted over the top of each rail; it holds the top of the ladder against poles, building corners, pipes and other vertical projections. High dielectric properties of the rubber sling permit use around electrical installations, says company, and the fabric reinforcement within it increases strength and service life. Bulletin 460–25C gives details. Industrial Ladder Co.

24—BOILER-BURNER UNIT is efficient, space saving

Petro-Pac is a boiler-burner unit (gas or oil fired or both) reported to operate at more than 80 per cent efficiency and reduce installation head room by as much as 24 in. The latter is due to design improvements which make a conventional boiler base unnecessary. Involving a burner meshed into the firebox type boiler, the re-designed firebox forced draft package unit will service steam or hot water requirements of buildings containing 6000 to 60,000 sq ft of floor service. Output range is given as 396 to 1800 MBtu per hour. Other features noted by manufacturer include a sealed combustion system, elimination of refractory combustion chamber, and of

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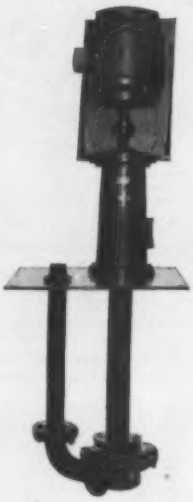
This **NAGLE PUMP** is a "relief" around Industrial Plants!

This Nagle type "CWO-C" vertical shaft centrifugal pump is a "relief" to plant engineers because it gives trouble-free service and is easy to maintain, all parts being readily accessible. It has a non-clogging impeller, designed specifically to handle sludge or abrasive slurries. All parts in contact with material being pumped are of abrasion or corrosion resistant alloy. No bearings below the floor plate—no rubbing contact between revolving and stationary parts below this level.



Available in sizes from 1" to 16", capacities to 8000 GPM, and heads in some cases up to 230'. The type "CDO-C" is similar, but is for dry pit operation.

Nagle pumps are available for handling all types of corrosive, gritty, viscous or hot liquids. They give outstanding performance on ash handling.

SALES REPRESENTATIVES IN PRINCIPLE CITIES

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NAGLE PUMPS, INC.
1267 CENTER AVE., CHICAGO HEIGHTS, ILL.

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Users report actual proof that OXI Crystals have cut coal costs substantially, reduced firebox and boiler cleanup costs up to 75%!

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*Also ask about **KOR**—world's most powerful fuel oil additive, and **SURFBLOW**—the floating boiler water skimmer.*

OXI CORPORATION 86 Box 485, Gary, Indiana

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chimney or smokestack due to pressure firing. (Only a vent for exhaust gases is required.) Prices are said to compare favorably with field installation of a boiler with base and conversion burner plus wiring and combustion chamber. Form 3534 gives data. Petro.

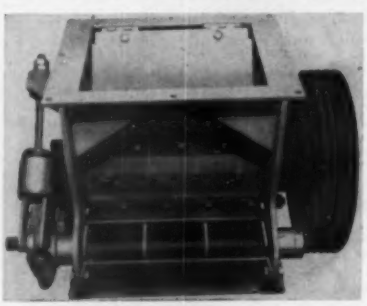
25—PORTABLE RECORDER registers watts, vars on one chart

The Type CF-8 Recorder is a portable hook-on unit that registers watts and vars on a single strip-chart. Designed to provide an easy, low-cost means of

checking power consumption efficiency and obtaining data for power-factor correction, it uses an inkless mechanism, taps its two records side by side — watts for 50 sec, vars for 10 sec. Phase-shift and time-switching mechanisms that obtain the var measurement are self-contained. Recorder can use a Type G-4 split-core current transformer that "hooks on" line, permitting readings to be made without service interruption. Although a single-phase instrument, recorder can be used in polyphase circuits. General Electric Co.

26—CRUSHER lets non-crushable material pass through

The Triumph is a single-roll crusher designed for reducing friable material, even that containing noncrushable matter. It is suggested for breaking up any material having a tendency to cake or become encrusted. Tramp metal, rocks,



stones, etc., pass right through, company says, without damaging machine or slowing it down. Because of this, the Triumph can be used in many installations instead of larger and more expensive hammermills, company points out. An air-cushioned breaker bar serves as a release mechanism for foreign bodies, absorbing shock overloads. By eliminating shock-overload, long-wearing tool steel can be used for teeth and bar. Tooth holders and breaker bar can be

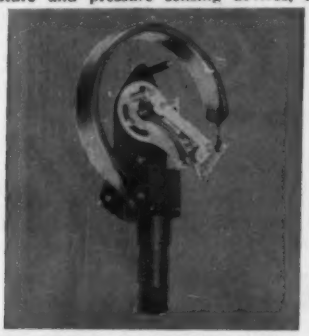
THE LONERGAN LINE

HOW TO MAKE A GOOD IDEA BETTER

by Norman J. Smith

In this hurry-up age of missiles and electronics, it is often possible to overlook the fact that because a device or an idea is new, it is not necessarily the best.

For example, while there are many temperature and pressure sensing devices, none



has such universal application as the Bourdon tube, which was first conceived in 1849 by a French engineer, Eugene Bourdon.

Today, a modern "C" type Bourdon tube gauge, such as the Lonergan Maximon makes full use of Bourdon's original idea. At the same time, it utilizes the finest materials such as K Monel stainless steel, beryllium, copper and many, many others in order to improve Bourdon's basic invention. Other improvements are: twisted spiral tubes to measure the output of pressure transducers; long helical tubes with heavy walls to measure pressures up to 100,000 psi; and small tightly coiled tubes for movementless gauges.

While the power plant man with a gauge problem isn't concerned with all of these forms, it is interesting to note that in his application for a patent more than a hundred years ago, Bourdon anticipated all of these present day variations. He claimed application on all forms of curved or twisted tubes whose transverse sections differed from circular forms for temperature and pressure measuring, indicating and controlling of fluids.

The Lonergan gauge today incorporates all of the known advances in the Bourdon tube in any one of three lines. For applications requiring the finest gauge available anywhere, the Lonergan Maximon is the choice.

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Norman J. Smith

Chief Engineer, Instrument Division

Lonergan

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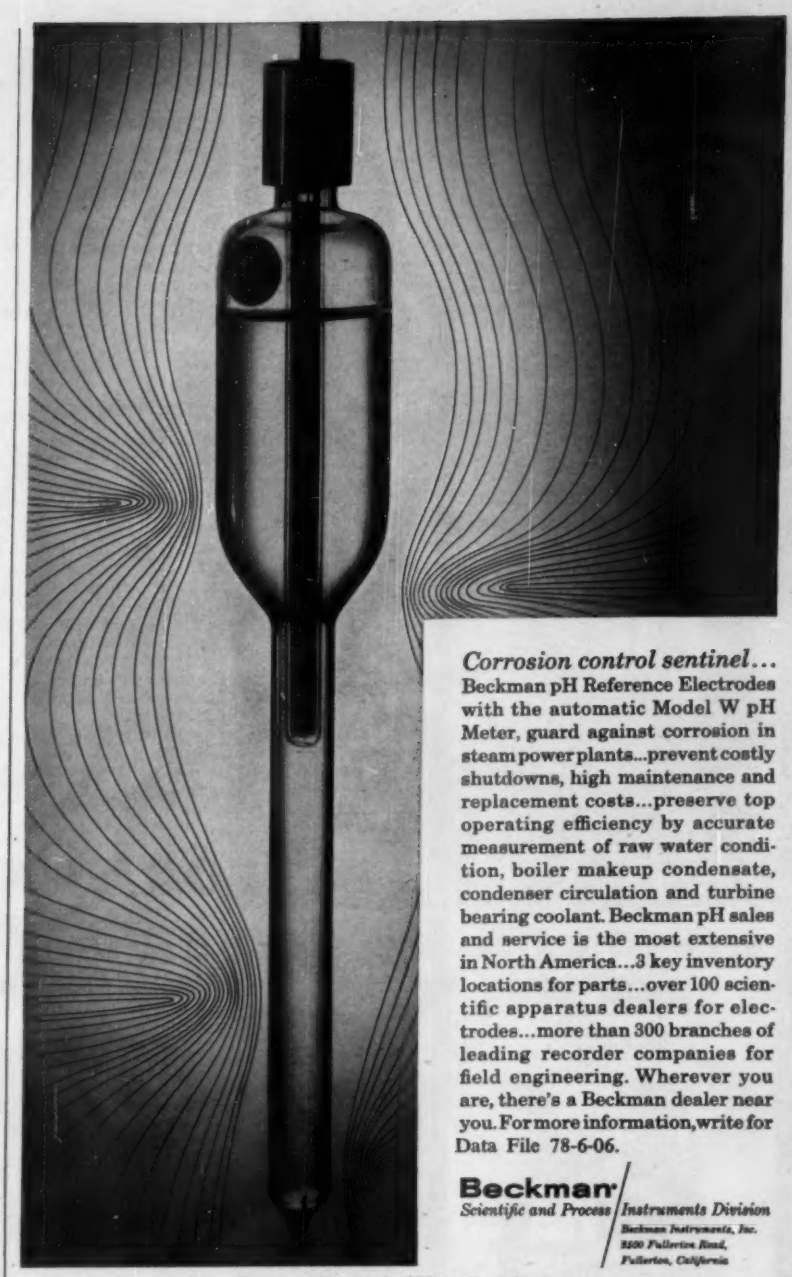

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Beckman pH Reference Electrodes with the automatic Model W pH Meter, guard against corrosion in steam power plants...prevent costly shutdowns, high maintenance and replacement costs...preserve top operating efficiency by accurate measurement of raw water condition, boiler makeup condensate, condenser circulation and turbine bearing coolant. Beckman pH sales and service is the most extensive in North America...3 key inventory locations for parts...over 100 scientific apparatus dealers for electrodes...more than 300 branches of leading recorder companies for field engineering. Wherever you are, there's a Beckman dealer near you. For more information, write for Data File 78-6-06.

Beckman
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Beckman Instruments, Inc.
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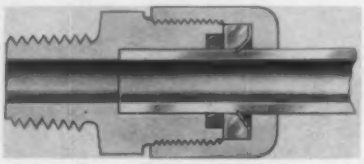
You'll find two postage-free Reader Cards on pages 119–120. Use them for ordering product information—just circle item numbers of the products you would like to know more about. You may also use the cards for requesting advertised catalogs.

reversed to provide wear surfaces on both sides. Teeth can be replaced. The C. O. Bartlett & Snow Co.

27—IMPROVED FITTING connects tubing in seconds

Fast-Tite Fittings connect copper, plastic, or aluminum tubing. With them, says manufacturer, connections are made without usual clamps required with an insert-type fitting as used with plastic pipe, and without flaring, belling or soldering usually done in connecting metal tubing. It is explained that by merely inserting the tube in the fitting

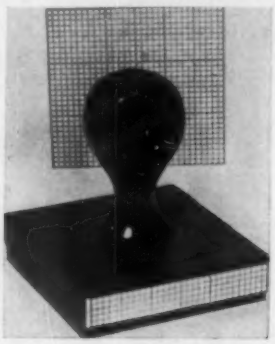


with a twisting motion — as far as the tubing will go — you get a connection that is leakproof for vacuum, gases, and fluids, over a wide range of pressures and temperatures. This is attributed to use of a butyl O-ring seal partially embedded within the fitting. A serrated spring steel ring, positioned ahead of this seal, bites slightly into the outer tube surface to strengthen the fitting when tube and fitting are placed in tension.

Since the Fast-Tite Fitting is an OD type, there is no restriction to flow, company notes; it can be applied on small diameter plastic tubing. And because it presents no inner obstruction to the pipe line, it is suggested for plastic tubing used as underground conduit. This fitting comes assembled for use, but can be disassembled for re-use. When installed, it can be turned 360 deg without lessening effectiveness of the seal or reducing the grip of the tube, company points out. Fast-Tite Fittings are for use with standard ¼- to 2-in. tubing, are made from nylon, Cycolac or polypropylene resins. D & G Plastics Co.

28—RUBBER STAMP puts graphs where they're needed

With this rubber graph stamp you can include graphed material in notebooks, reports and correspondence. Instead of attaching separate sheets of graph



paper, you simply stamp a graph pattern — 3 in. square — wherever it is needed. The pattern has 100 blocks per square inch. The pad costs around $3.00. Edmund Scientific Co.

General Kinetics Corp.

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PRECISION CONTROL

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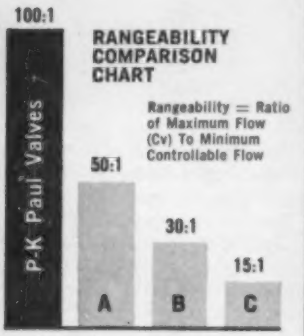
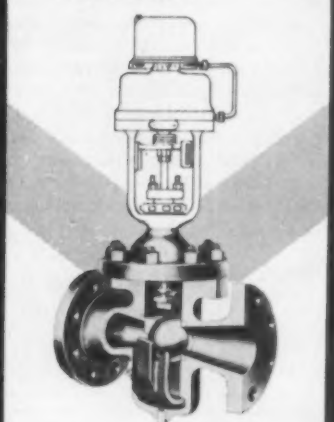


A—Globe Valves, V-Port Plug
B—Globe Valves, Contoured Plug
C—Butterfly Valves



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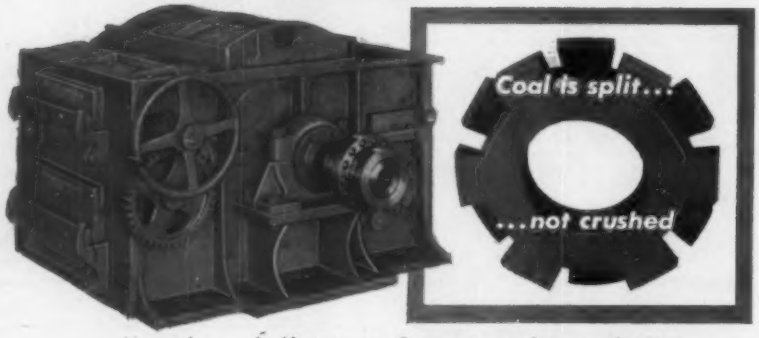

More than a half-century of experience has resulted in consistent improvement in American crushers, yet the rolling ring principle (patented in 1908) still remains the most efficient. Hundreds of "cost of operations" reports from American users prove this fact.

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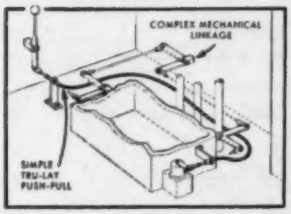
TRU-LAY PUSH-PULL DATA FILE SHOWS HOW TO SIMPLIFY AND IMPROVE DESIGN



Push-Pull remote controls, shown here, are flexible, have but one moving part, and give a lifetime of accuracy. Mechanical linkages are complex, are made of many parts, wear at many points, and produce increased backlash, lost accuracy, and vibration rattles.

This Push-Pull Data File—containing 7 engineering bulletins—will show you how these flexible controls have eliminated mechanical linkages on hundreds of products. You can make *your* products more useful, easier to sell, with Push-Pull controls. Write for your Data File today.

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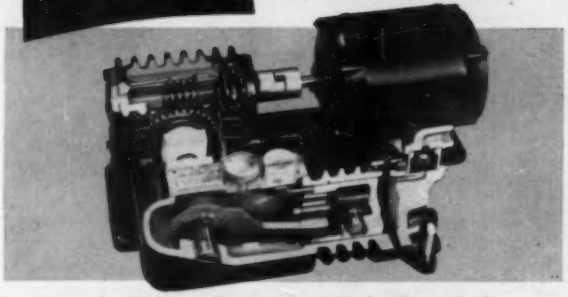
New MADDEN *Metriflow* Metering Pump



the only thing ordinary about it is the price!

- Unitized construction; no moisture or dirt gets in—no oil or grease leaks out.
- Built like a tank. Machine-cut gears; outboard bearings on drive shaft; piston-supported diaphragm.
- Ideal for slurries and corrosive liquids; solution heads available of stainless steel, Hastelloy, etc.
- Duplex models double capacity from one motor, by alternating power strokes.
- 4 standard sizes—0 to 10, 18, 36 or 54 GPH; pressures to 300 psi. Adjust capacity while operating.

MADDEN

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Two 150 hp Ideal Squirrel Cage Induction Hollow Shaft Vertical Motors at City of Detroit's new Spring Wells Pumping Station

Three 400 hp Ideal Wound Rotor Induction Solid Shaft Vertical Motors in another area at Spring Wells Pumping Station

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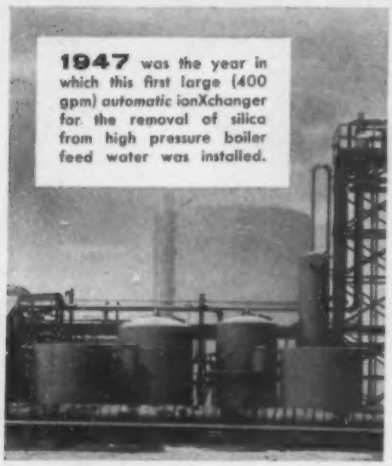
PATHWAYS OF A PIONEER

ILLCO-WAY DESIGNERS AND BUILDERS

MODERN EQUIPMENT FOR ionXchange


1947 was the year in which this first large (400 gpm) automatic ionXchanger for the removal of silica from high pressure boiler feed water was installed.

Blazing the Way for De-I Developments

Again we bring you an example of how IWT has always been in the forefront of the development of practical and successful ion-exchange equipment. The big boiler-water de-ionizer shown above is now more than 12 years old, is still in operation, and has been joined by two more IWT units of similar size in this sprawling midwestern chemical plant. Many other early users of ILLCO-WAY ionXchange have since *added to* and *modernized* their installations as new developments became available.

The pioneering work which IWT started in 1937, with the advent of the first commercial ionXchange resins, is still being carried on — for the benefit of present users of IWT equipment, as well as future customers. New ideas, new processes, new resins, new methods of construction, new materials, new parts and accessories — all these are under constant consideration from the foundation of long experience and with the zeal of the forward look.

THIS EXPERIENCE CAN MEAN A LOT TO YOU

If you need pure water for high-pressure boiler make-up or process use, or if you are considering the use of ion-exchange for purification or concentration of chemical products, be sure to take advantage of IWT pioneering experience and specialized knowledge. *Call your IWT representative.*

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Seveneering" with R/M

for packings that are chemically impervious

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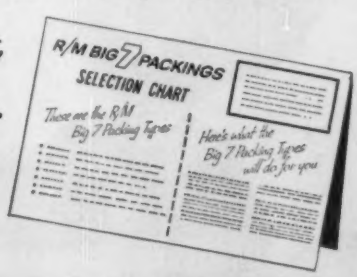
This new R/M Big 7 Chart is a mighty handy reference. Send for your copy now.



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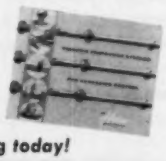

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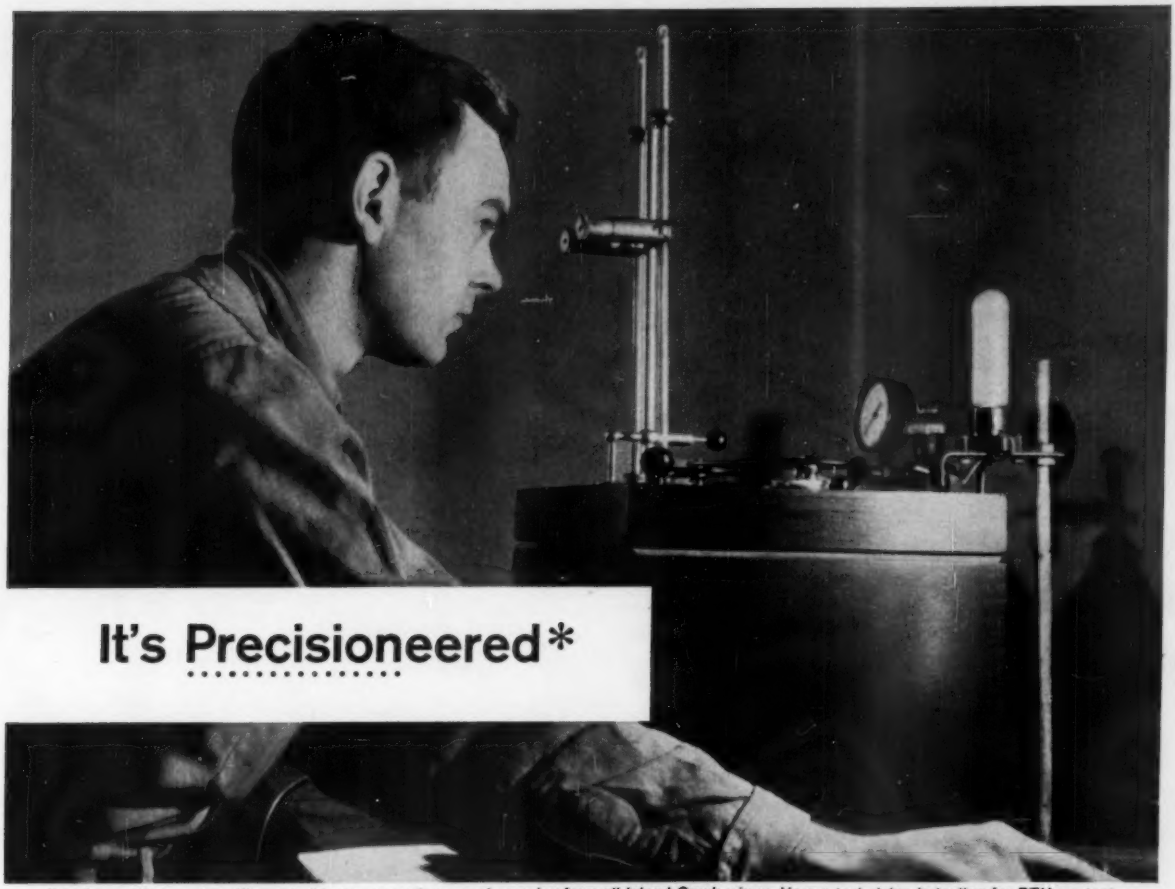
How is it possible for Island Creek coal to lower the cost per 1000 pounds of steam? . . .



It's Precisioneered*

Regular and frequent quality control tests are made on coal samples from all Island Creek mines. Here a technician is testing for BTU content.

* PRECISIONEERING is a chain of controlled events that actually begins and ends at your burning equipment. It starts with the question: What kind of coal does your equipment require to produce steam at the lowest net cost per 1000 lbs.? It provides the answer, through penetrating engineering and evaluation studies. It produces the answer . . . with superior seams of coal prepared exactly to your determined specifications in modern preparation plants, using precision engineering techniques and strictest laboratory controls. We'd welcome a chance to discuss the possible reduction of your net costs through Precisioneering. Write. Or phone. No obligation, of course.

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Zero leakage nuclear pumps

Four BJ Liner-Motor Pumps Provide Primary Cooling for AEC's SPERT-III Project

High temperature, high pressure and high capacity performance *with zero leakage* are demanded of these four Byron Jackson Liner-Motor Pumps. Employed to handle pressurized water for primary coolant at the Atomic Energy Commission's SPERT-III project near Idaho Falls, the 500 HP pumps are operating at 650° F, 2500 psig, and are rated at 5000 GPM with a total dynamic head of 350 feet.

In building pumps to such critical requirements, BJ calls upon the engineering skills and manufacturing methods that have made Byron Jackson a leader in nuclear pumps for all types of reactors...stationary, or portable. The success of BJ nuclear pump design is proved through the installation or specification of BJ Pumps on practically every major commercial reactor in the United States.

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